Vol. 5 JANUARY, 1912 No. 3

QUARTERLY

OF THE

National Fire Protection Association

Entered as second-class matter May 1, 1911, at the Post Office at Boston, Mass., under act of July 16th, 1894.

87 MILK STREET, BOSTON, MASS.

EDITED BY THE SECRETARY

National Fire Protection Association.

President—WILLIAM H. MERRILL.
Vice-President—C. H. PHINNEY.
Secretary and Treasurer—FRANKLIN H. WENTWORTH,
87 Milk Street, Boston, Mass.

Active Members.

American Institute of Architects.
American Institute of Electrical Engineers.
American Electric Railway Association.
American Warehousemen's Association.
American Water Works Association.
Associated Factory Mutual Fire Insurance Cos'. Inspection Bureau.
Association of Fire Underwriters of Baltimore City.
Board of Fire Underwriters of Allegheny County.
Board of Fire Underwriters of the Pacific.
Board of Fire Underwriters of the Territory of Hawaii.
Boston Board of Fire Underwriters.
Buffalo Association of Fire Underwriters.
Canadian Fire Underwriters' Association.
Canadian Manufacturers Association.
Chicago Board of Underwriters of Chicago.
Cincinnati Fire Prevention Bureau.
Cleveland Inspection Bureau.
Cotton Insurance Association.
Electrical Supply Jobbers Association.
Factory Insurance Association.
Factory Mutual Laboratories.
Fire Underwriters' Electrical Bureau.
Fire Underwriters' Inspection Bureau.
Hudson Inspection Bureau.
Illinois Inspection Bureau.
Indiana Inspection Bureau.
Indiana State Fire Prevention Association.
Insurance Association of Providence.
International Acetylene Association.
International Association of Fire Engineers.
Iowa State Fire Prevention Association.
Kansas Fire Insurance Inspection Office.
Kentucky Inspection Bureau.
Kentucky State Fire Prevention Association.
Louisiana Fire Prevention Bureau.
Louisville Board of Fire Underwriters.
Mainland Fire Underwriters' Association of British Columbia.
Mass. Assn. of Municipal Electrical Inspectors.
Massachusetts Mutual Fire Insurance Union.
Michigan Inspection Bureau.
Michigan State Fire Prevention Association.
Middle States Inspection Bureau.
Milwaukee Board of Fire Underwriters.
Minnesota State Fire Prevention Association.
Mississippi Inspection and Advisory Rating Company.
Missouri Fire Prevention Association.
Missouri Inspection and Survey Bureau.
Mutual Fire Prevention Bureau.
National Association of Cement Users.
National Association of Credit Men.
National Assn. Factory Mutual Insurance Companies.
National Association of Local Fire Insurance Agents, The
National Association of Manufacturers of United States.
National Assn. of Master Gravel and Slag Roofers of America.
National Assn. Sheet Metal Contractors of United States.
National Board of Fire Underwriters.
National Electrical Contractors' Association.
National Electrical Inspectors' Association.
National Electric Light Association.
National Hardware Association of U. S., The
National Paint, Oil and Varnish Association.
Nebraska Inspection Bureau.
Nebraska State Fire Prevention Association.
Newark Inspection Bureau.
New Brunswick Board of Fire Underwriters.
New England Bureau of United Inspection.
New England Insurance Exchange.
New Hampshire Board of Fire Underwriters.
New York Board of Fire Underwriters.
New York Fire Insurance Exchange.
North Dakota State Fire Prevention Association.
Nova Scotia Board of Fire Underwriters.
Ohio Inspection Bureau.
Ohio State Fire Prevention Association.
Oklahoma Inspection Bureau.
Philadelphia Fire Underwriters' Association.
Philadelphia Suburban Underwriters' Association.
Rocky Mountain Fire Underwriters' Association.
Royal Architectural Institute of Canada, The
South Carolina State Fire Prevention Association.
South-Eastern Underwriters' Association.
St. Louis Fire Prevention Bureau.
Suburban Fire Insurance Exchange.
Tennessee Inspection Bureau.
Texas Fire Prevention Association.
The Union.
Underwriters' Assn. of the Middle Department
Underwriters' Association of New York State.
Underwriters' Bureau of Middle and Southern States.
Underwriters' Bureau of New England.
Underwriters' Laboratories, Inc.
Virginia Fire Prevention Association.
Western Actuarial Bureau (Fire).
Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Sprinklered Risk Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.
Wisconsin State Fire Prevention Association.

Table of Contents.

NINE HUNDRED TONS OF REFRIGERATION ..... FRONTISPIECE

EDITORIAL 261

PUBLIC EDUCATION 267

SYLLABUS FOR PUBLIC INSTRUCTION IN FIRE PREVENTION 274

INDIVIDUAL RESPONSIBILITY FOR FIRES IN FRANCE 279

COMPARATIVE STATISTICS OF FIRE LOSS 281

BE CAREFUL. *From the Brooklyn Eagle* 284

"UNJUST TO WOODEN SHINGLES." *Editorial in Mississippi Valley Lumberman* 285

RUBBER-COVERED ELECTRIC WIRES AND CABLES 286

MAKING AN ELECTRICAL CODE FOR NEW YORK CITY. *Hubert S. Wyncoop* 288

MECHANICAL REFRIGERATION. *Alexander M. Blumenthal* 291

FREEZING PREVENTIVES FOR WATER PAILS AND CHEMICAL EXTINGUISHERS. *J. Albert Robinson* 312

DEPARTMENT OF FIRE RECORD 321

CARPET YARN AND WEAVE MILLS—FIRE RECORD 323

UNSATISFACTORY SPRINKLER FIRES 345

FIRE-RESISTIVE BUILDINGS—FIRE RECORD 355

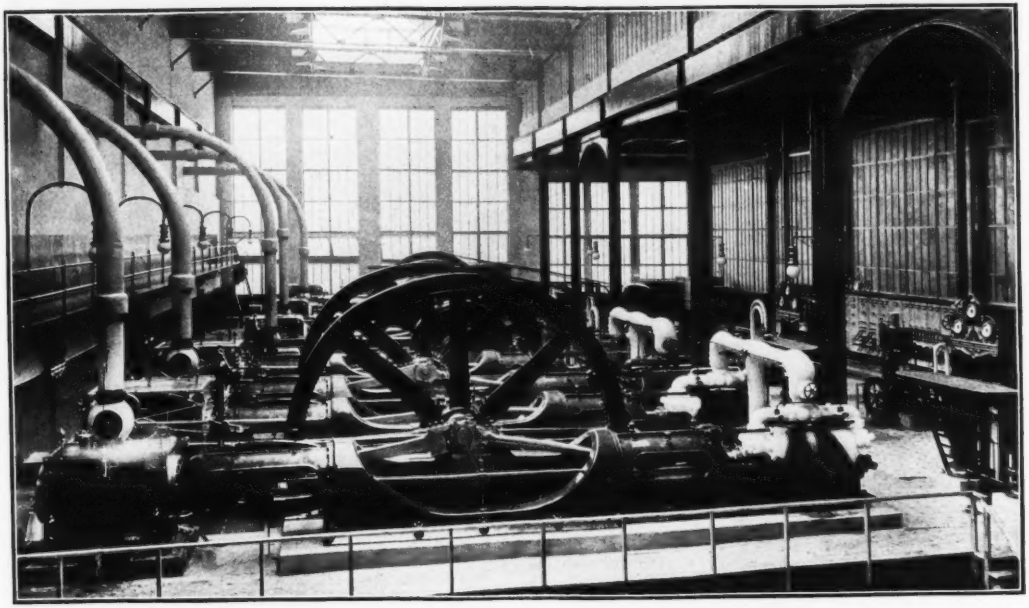
MISCELLANEOUS FIRES 361

FIRE CAUSES 374

POINTS OF INTEREST FROM FIRE REPORTS 379

STANDARD RULES AND REQUIREMENTS 384

Reports on fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.



Nine Hundred Tons of Refrigeration (Armour & Co., Chicago).
Article on Mechanical Refrigeration.

President Merrill says: "As to the matter of aviation, the burning wooden shingle is something of a flyer itself."

The Quarterly

Vol. 5 January, 1912 No. 3

The Criminal Match. Our active member the Union (Western), through its Committee on Publicity and Education, is attempting the ungrateful task of gathering the statistics on fires caused by matches—ungrateful because the result must at best be only faintly indicative of the enormous number of fires for which the match is responsible. As reported by the committee, in September there were 523 fires due to the careless use of matches, entailing a property loss of $159,403 and an insurance loss of $148,640. During October the property loss was $152,397 and the insurance loss $143,379. During the period between April 1 and November 1, 1911, the total property loss reported was $1,200,742, with an insurance loss of $1,084,216. Only about one-third of the insurance companies are making regular reports, therefore these figures are principally valuable in confirming what we already know—that the criminal match is making its hourly contribution to the national ash heap.

Meanwhile the newspapers are chronicling more grewsome figures than those relating to destroyed property. The following editorial from a recent issue of the *Cleveland Plain Dealer* is typical of the marked paragraphs in newspapers which are constantly being sent to us by our members in the United States and Canada:—

Babies and Matches.

Within three days in Cleveland five babies have been burned to death in homes where they were left alone during the absence of their parents. As nearly as can be ascertained, these fatalities have been due to the children being left within reach of matches.

It is unfortunate that very young children ever have to be left by their parents. Whenever such a necessity exists, however, the mother should take care that neither matches nor open fires are within reach.

Fire deaths of this kind within three days is a striking object lesson. It should serve to put an end to at least one variety of infant mortality in Cleveland.

It is perfectly obvious to us, and has been for a long time, that the "strike anywhere" match has no legitimate place in the home, and that the husband and father who loves his family will exclude it from his house

as he would a pestilence. But almost the same arguments may be brought against its use in the store or factory. It is everywhere a menace, and the argument that it is *convenient* is the barrier behind which its advocates seem to take shelter. In two states, Massachusetts and North Carolina, the legislatures have been asked to pass bills prohibiting the sale of any match igniting on other than prepared surfaces. The argument for convenience was the one chosen by the opponents of the measures in both states. At the hearings on the bill in Massachusetts the representative of one of the match manufacturers pleaded with tears in his voice that the committee should not inflict so cruel a hardship upon society. He painted, with deep emotion, the picture of a gentleman in evening dress with the curve of his waist line irretrievably ruined by the projection of a box of safety matches in his hip pocket.

The committee was visibly affected.

When economic interests are once adjusted to any special form of production, such as the match interest to the parlor match and the lumber interest to the wooden shingle, readjustment is almost like a surgical operation. The dollar is so near and comfortable, and the babies burned to death in Cleveland are so remote. The thing that is nearest affects us most. But a proper regard for the common welfare must eventually weigh all things in the balance and self-interest yield willingly, or be made by law to yield, to the public safety.

* * * * *

New York Fire Traps. It is not, however, only the manufacturer of profitable goods which may endanger human lives whose economic interests may make them slow to recognize their ethical obligations. Landlords are notoriously culpable in this respect, and often maintain fire traps even when well aware that the dollars which come from them may be a contribution of fire and death.

One of the best edited of our technical contemporaries, *Fire and Water Engineering*, has this to say of a specific instance in New York:—

> The newly created Fire Prevention Bureau of this city has a splendid opportunity to exercise its prerogative in the prosecution of the persons who are responsible for the existence of many fire traps on the bowery. The William Astor estate was last week charged in the Tombs Court with being responsible for some of the worst of these dilapidated structures, not, however, until after the agent had refused to remedy the conditions when so ordered by the building department. When arraigned in court the agent pleaded for an extension of time, which was granted by the magistrate, despite the protests of the assistant corporation counsel. The building in question is what is known as the Uncle Sam Lodging House, and is the rendezvous of scores of men both night and day. Should the trap burn during the next week, causing loss of life, who would be held responsible? For nearly two years past the building department has been using all the means in its power to persuade the managers of the Astor property to comply with the law, but have met with rebuff and defiance, and now when the Fire Prevention Bureau with its inexorable power steps in, a city magistrate feels it incumbent upon him to show further leniency. In this particular case there seems on the surface to be

no extenuating circumstances that warrant further delay in prosecuting the arrogant violator of a law that is meant to conserve human lives.

Beside the callousness of a New York landlord this paragraph illustrates the need long since pointed out by fire prevention engineers—that of a central authority and undivided responsibility for the elimination of fire-breeding conditions in the metropolis. The new Fire Prevention Bureau may prove to be the force and influence long prayed for.

* * * * *

Factories in Cities. The Factory Investigating Commission, appointed by the legislature of New York State for the purpose of evolving proper methods of protecting factory employees from fire and other dangers, has been holding meetings and taking testimony during the past month. In reply to the question, "Should manufacturing be prohibited above a certain number of stories and if so, what should be the maximum?" one of the witnesses replied:—

I believe that manufacturing should be prohibited above the sixth story. Any modern factory can meet all necessary requirements inside this prohibition. Factory conditions in New York city are abnormal. It is the presence of cheap foreign labor in certain districts of the city which makes the operation of factories in the densely populated sections of the metropolis profitable. An enlightened society would conduct its manufacture in suburban districts where work might be carried on in buildings of reasonable height.

The question this answer suggests, that there is a problem behind a problem, must have occurred to the commissioners many times in the course of their investigation. The great city is abnormal and hence life within it is abnormal. In Illinois, as in New York State, the draining of population from country to city continues, and at an alarming rate. The recently published census figures show that while in 1900 54 per cent of the people of Illinois lived in towns of over 2,500 inhabitants, in 1910 the proportion had increased to 62 per cent. Moreover, more than half the total increase of population in 10 years was made by Chicago, and the rural districts hardly increased at all. The figures are as follows:—

	1910.	1900.	Increase.	Per cent.
Urban,	3,476,929	2,666,333	810,596	30.4
Rural,	2,161,662	2,155,217	6,445	0.3
	5,638,591	4,821,550	817,041	16.9

But there is no reason for the fear sometimes expressed that this urban drift will result in an inadequate food supply. It is largely offset by improved farm machinery and methods of agriculture, and indeed to a certain extent the depopulation of the country is due to the fact that fewer workers are needed than formerly. The real problem is not to provide for the cultivation of the land, but to guard against the dangers that spring from undue concentration in cities. The decentralization movement can be successful only if it provides for carrying into the country some part of the work now unnecessarily done in cities.

Water Supplies and Population. Other problems present themselves along with increased population even in those sections which, unlike Manhattan, have ample space in which to expand. The question of an adequate water supply is certain to be one of growing importance in most of the states.

That these difficulties will be successfully overcome only by tremendous expenditures of money is being illustrated by the cities of New York and Los Angeles, both of which are constructing vast works to enlarge their supplies. The latter city is constructing a system that will convey water over two hundred miles, a distance which is among the greatest a city has ever found it necessary to go to obtain suitable water in sufficiently large quantities. In this undertaking some unusual problems are being encountered and their solutions are matters of peculiar engineering interest.

Few if any cities showed a greater growth in population during the past decade than Oklahoma City, and this city now encounters what may be a severe handicap to its desired development in a threatened lack of water. Oklahoma City is situated on the North Fork of the Canadian River, somewhat west of the center of the state, than which there is no more fertile area in the Union. There is enough water in Western Oklahoma for the present population; there is water enough for twice and perhaps three times the present population, but as the population increases, as it must inevitably increase, it will eventually be found that the water supply is not adequate for the demand made upon it. The Canadian River, from which Oklahoma City derives its water supply, dries up periodically, so that not enough water can be had for all purposes. This is the condition at the present time, although a sufficient quantity is held in reserve for use in case of fire. The matter of an adequate water supply not only confronts the state of Oklahoma, but other states of the plains, including the Dakotas, Montana, Wyoming, Colorado, Nebraska, Kansas and Texas.

* * * * *

Help from the Architects. There could be no better illustration of the fact that the present growth and influence of our Association is due to the constant thought and devotion of a large number of our members, occupied in their different walks of life, than the notes which come to us from the annual convention of our active member the American Institute of Architects, which assembled last month in Washington, D. C. Two of our valuable members in the profession of architecture brought the matter of our work prominently before the convention. Mr. D. Everett Waid, in connection with the report of the committee of which he is chairman, again urged a closer co-operation between the American Institute of Architects and the National Fire Protection Association. Mr. Robert D. Kohn, who has for a number of years been a member of our Executive Committee, and who is an authorized representa-

tive of the American Institute in our councils, prepared a resolution which was unanimously adopted on the recommendation of the Committee on Resolutions. In substance this resolution provided that in view of the importance of the movement for fire protection so ably conducted by the N. F. P. A. the Board of Directors of the Institute be requested to arrange an occasion at the next annual convention when the representatives of the N. F. P. A. may present to the convention a report on the ways in which the architects of the country and the N. F. P. A. may co-operate in this important phase of conservation.

Both Mr. Kohn and Mr. Waid are prominently identified with the committee now at work upon the new building code for New York City. It is obvious that if the individual architects are ever to co-operate largely in the work of fire prevention the credit of bringing about such a desired consummation will be due principally to the efforts of Mr. Kohn and Mr. Waid, whose prominence and efficiency in their own profession bespeaks for their recommendations the respectful consideration of their own craft and fellowships.

* * * * *

The Brooklyn Fire Alarm System. Several years ago an exhaustive investigation was made of the fire alarm system of Manhattan Island, New York City, on behalf of the fire underwriters, and it was discovered that the system was in so deplorable a condition that the safety of the city was threatened.

The matter was brought to the attention of the authorities, and we understand that a new system is now in process of installation. A similar investigation of the fire alarm system in the Borough of Brooklyn, New York, has just been made by the engineers of the National Board of Fire Underwriters, and it is found that the Brooklyn system is dangerously unreliable and very inadequate. The conditions are such that it is possible for a small, and in itself relatively unimportant, fire to put the system out of operation. It would seem to be the duty of the city authorities to do whatever is necessary for the protection of the great Borough of Brooklyn, and to do it as promptly as is mechanically possible, even if it is necessary to pare down the expenses in other branches of the city government. The safety of the lives and properties of the people of the borough should be given the first consideration.

* * * * *

The Current Quarterly. We desire to call attention to one or two features of this issue beside the special fire record and statistics on carpet mills. The valuable and painstaking article on mechanical refrigeration is an eloquent tribute not only to the ability and industry of its author, Mr. Blumenthal, but a striking manifestation of his interest in the Association of which he is a member. Our original article on this subject, published many years ago, was contributed by Mr. Blumenthal,

and the demand for it quickly exhausted the issue in which it was printed. The article in this issue is a revision of the original contribution brought down to date by the author.

The syllabus for use of teachers in schools and colleges who desire to make a beginning in fire prevention instruction was sketched out by the secretary in response to a multitude of letters upon the subject. It is recognized that the syllabus as given is merely suggestive and that a very great work lies before the Association in the compilation of a complete text-book, acceptable not only from a scientific but from a pedagogical standpoint as well. It is hoped that some progress in this important work may be made during the coming year.

The demand for proper mixtures of non-freezing compounds for fire extinguishers and fire pails has been so great and so continuous as to induce us to reprint Mr. Robinson's article on the subject contributed some years ago. One striking feature of this article is the singular susceptibility to freezing of sulphuric acid containing certain percentages of water. The extraordinary behavior of this product, as indicated by the plotted curve contained in the article, makes advisable the consideration of Mr. Robinson's suggestion that before using for such purposes the acid be deliberately diluted past the point of its erratic behavior.

One of the most astonishing individual fire reports which we have ever presented to our readers will be found under number 11,576, descriptive of the fire in the wood and paper box factory of Fred. J. Derry of Danvers, Mass. Although we have reported many fires giving evidence of intentionally crippled water supplies, valves, connections and special controlling devices, we do not remember ever before encountering an equipment of automatic sprinkler fire protection in which a large number of sprinkler heads were plugged with cork. The discovery of this clever manipulation reflects great credit upon the inspection department of our active member the Underwriters' Bureau of New England, of which Mr. Gorham Dana is manager.

Public Education.

Well written and instructive articles on the Fire Waste continue to appear from sources other than our own, but for which the material is generally furnished by our members. The most interesting contribution to current magazine literature on the subject is that of Mr. Arthur E. McFarlane's on the conflagration hazard of New York City, which appeared in the December number of *McClure's*. Even those of us who consider ourselves well posted on the hazards of the metropolis were fortified by the essential clearness of Mr. McFarlane's article. His preliminary research was so thorough as to enable him to give to his readers a mental picture of the construction and special hazards of the city which will not be easily effaced. The publication of such articles must have a wide influence in driving home to the American people the truths which this Association has long attempted to promulgate.

Mr. McFarlane is now preparing an article for *Collier's* on the subject of arson or deliberate incendiarism.

* * * * *

The most hopeful public recognition of the subject of the fire waste which has occurred since our last issue was that of the Minnesota Fire Prevention Congress called by the Governor for November 8th, at St. Paul. At this meeting official representatives from all over the state of Minnesota were present, Governor Eberhart stating at the meeting that he had never seen so many mayors and other officials of Minnesota cities before assembled in one place. One might gather an idea of the seriousness with which the matter was discussed from the fact that there were both afternoon and evening sessions, and that the attendance did not lag at either of them. The large palm room of the St. Paul Hotel would not accommodate the crush of people at the afternoon session. Many women were present during the congress.

The National Fire Protection Association was represented by three of its members, Fire Marshal C. J. Doyle of Illinois, Fire Commissioner Palmer of Michigan, and Secretary Franklin H. Wentworth of Boston. The St. Paul Association of Credit Men was represented in the speaking by its President, Mr. H. W. Parker, who contributed an unusually forceful and interesting address. Mr. Parker is a brother of the English novelist, Sir Gilbert Parker, but demonstrated clearly that he possesses literary ability all his own. The Governor of the state and the Mayor of

St. Paul, as well as Insurance Commissioner J. A. O. Preus, were the presiding officers at the sessions. It was a meeting of national as well as state-wide importance, and made a profound impression upon the officials of the cities which sent delegates. The addresses delivered at this congress have just been assembled in a pamphlet by Northwest Insurance, of Minneapolis. Secretary Wentworth's address is republished in attractive dress by our active member the Mississippi Inspection and Advisory Rating Company, of Vicksburg, Miss.

* * * * *

Our active member the National Association of Credit Men, following its effective campaign of last season, in which it arranged "Fire Prevention Nights" at its local branches in over twenty of the principal cities east of the Mississippi River, has planned an attack upon the western and southern territories for the present season. Beginning in Boston on January 16th, at the annual dinner of the Boston Association of Credit Men, Secretary Wentworth is to speak constantly for two months under the Credit Men's auspices, in a tour including the cities of the Pacific Coast. Mr. Charles E. Meek, for ten years Executive Secretary of the National Association of Credit Men, now Assistant Cashier of the Fourth National Bank, New York, is to accompany Secretary Wentworth on this unusually arduous campaign. Mr. Meek is himself an interesting and effective speaker, and is to share with our Secretary the honors of the program. All the meetings have been arranged by the local bodies of the Credit Men in the cities to be visited. The city officials and officials of other municipal and civic organizations are invited to co-operate. The meetings are to be usually in the form of a dinner, but in some cities evening meetings have been arranged to which the public is to be admitted. Following is the itinerary:—

January 16th, Boston, Mass.; 23d, Buffalo, N. Y.; 24th, Cleveland, Ohio; 26th, Milwaukee, Wis.; 27th, Grand Rapids, Mich.; 29th, Minneapolis, Minn.; 30th, St. Paul, Minn.; 31st, Duluth, Minn.; February 2d, Fargo, N. D.; 5th, Butte, Mont.; 7th, Spokane, Wash.; 9th, Seattle; 10th, Tacoma; 12th, Portland, Ore.; 15th, San Francisco, Cal.; 19th, Los Angeles, Cal.; 21st, San Diego; 26th, Salt Lake City, Utah; 28th, Denver, Colo.; March 2d, El Paso, Texas; 4th, Fort Worth; 5th, Dallas; 7th, San Antonio; 9th, Houston; 11th, New Orleans, La.; 13th, Montgomery, Ala.; 14th, Birmingham; 16th, Knoxville, Tenn.

* * * * *

Mr. H. B. McMaster, one of our Ohio members, delivered a very well-conceived address during the quarter at a dinner given by the Youngstown, Ohio, Credit Men's Association.

* * * * *

Hon. Robert Stone, of the Kansas Legislature, spoke upon Fire Prevention and Foreign Laws before a meeting of the Kansas State Fire

Prevention Association, in Topeka, on November 14th. Mr. Stone took the advanced position that the man who has a fire is not usually entitled to sympathy, and should be regarded as a public offender unless he can prove his innocence in the matter of carelessness or neglect. Following is an extract of interesting portions of his address:—

We are a nation of money makers, Europe is a people of money savers; we are a people of waste, they are a people of thrift. We figure that the most important thing is to make a dollar, and they that it is of equal importance to save one. This is evidenced in our hurried construction of inflammable buildings, and in their slow and solid masonry; in our willingness to pay a high rate of fire insurance with the attendant risk, and their insistence on a low rate and unceasing care; in our elaborate fixtures for the putting out of fires and their precaution in preventing fires. We regard a fire as a misfortune and sympathize with the man who has had one; they regard fire as a crime and investigate and punish the man who is guilty. Our temperament is also shown by the different view we take of an insurance policy. Here, if our property is insured and we have a fire, we do not count it as a loss, simply that we have transferred the loss to other and distant shoulders. There, the insurance is regarded as a tax, which is ultimately borne by every one. Here, we regard insurance as a gamble, and if there is a fire the insurance company has lost the bet. There, it is regarded as a means of reducing the loss to a certainty and borne by the whole community. Here, we figure that the insurance company restores the loss; they, that it really indemnifies the owner for a loss which can never be restored. Here, we figure a fire is an exchange of property for the ready money; there, they figure that a fire is an absolute loss of toil and natural resources. We figure a fire is a misfortune, they figure a fire is a crime. We endeavor to extinguish the fire, they labor to prevent it. We are losing a fortune every year, they are saving one.

The causes of the fire waste are twofold, physical and moral. The physical hazard may be measured, estimated, and may to some extent be corrected and controlled. The physical hazard consists of the damage that come from lighting and heating, from exposure to other buildings, bonfires, the working of machinery, the use of chemicals, defective flues and such things. These hazards may be reduced by care in construction, in using continual care in the employment of machinery, and use of fires, etc.

The moral hazard is hidden. It cannot be seen or made certain; it is impossible to estimate with any accuracy, or to prescribe by what rule or regulation it may be curbed. A moral hazard arises from failure of an enterprise to pay a dividend on the investment. The dead or dying plant stands like a sinister ghost inviting the owner to crime. It arises from financial embarrassment or from litigation, or it may come from an enemy, where, for instance, an offensive plant is erected in a community where the people object to its erection, or where a saloon is opened in a neighborhood which does not wish to have one. This may lead to incendiarism or to arson.

If our law required buildings to be erected of stone and brick, and shingle roofs, which are fire brands of great danger, were eliminated, and not only the construction, but the care of buildings, was under strict supervision of public fire marshals, and every man made responsible for the damage which might result from fire through his carelessness; if our valued policy law were repealed and no man was allowed to collect for more than his actual loss, and if the states had fire marshals to investigate the cause of the fire and prosecute the offenders, it would save hundreds of millions of dollars to our nation, to say nothing of life and limb. Each citizen ought to feel responsible for the fire hazard of his own community. He should realize that the parlor match, the trash heap, the oil-soaked rags, defective flues, and the storing of explosives, means not only damage to the life

and property of the owner, but perhaps of a whole city; that the question of fire prevention is more important than control, and that both of these are for the benefit of the individual and the community rather than the insurance company which may be carrying the loss. Last winter my colleague in the legislature, Mr. Olinger, with great care and ability, prepared and presented to that body a bill for state fire marshal. His facts and figures were convincing, and his arguments conclusive, but the members of the house seized the notion, stated by some inconsiderate member, that the whole plan was one to loot the treasury for the benefit of the insurance companies, and the bill was defeated by an overwhelming majority. This campaign of education begun here should be continued until the people of the state understand that any law which is to prevent fires is for their benefit and does not rob the public treasury.

* * * * *

Mr. H. W. Forster, Chief Engineer of the Independence Inspection Bureau, one of our Philadelphia members, has recently given good service to the cause of public education. On November 17th he appeared before the Engineers' Club of Rochester, N. Y., where he spoke on Building Construction and Private Fire Protection.

The points principally discussed related to the protection of vertical openings, protection against external exposure, relative merits of various types of fireproof construction, and automatic sprinkler protection. The new building code of the city of Rochester, which became effective last fall, had been studied prior to this meeting, and Mr. Forster pointed out that many favorable features had been incorporated in it, including brick or equivalent fireproof shafts for vertical openings in buildings, the use of wired glass and fire doors on these, and the provision of wired glass or shutters against exposures within thirty feet. The need of general protection against conflagration through the use of wired glass on all exterior wall openings was accented by Mr. Forster. He also called attention to the distinct need of making important requirements of building codes retroactive; that is, applying to existing buildings in so far as it is practical to incorporate those principles without unnecessary inconvenience; and suggested that there is no reason why a new building should be constructed properly and old buildings containing admitted weaknesses should be allowed to continue unchanged. He further advocated automatic sprinkler protection for mercantile and storage buildings of all kinds, especially in the congested sections, and an earnest plea was made for the installation of automatic sprinklers, provided with city supply and siamese connections as well, in the basements of structures of this character, because of the evident difficulty of fighting fires at such points.

The various phases of the lecture were illustrated with lantern slides.

On November 27th Mr. Forster addressed the Delaware County Firemen's Association at Chester, Pa. Several hundred members and guests were present, and the sphere of influence was particularly large, because the various delegates from a large number of companies were required to report the gist of the points brought out to the members who

had not been able to attend. The indirect audience therefore numbered from four to five thousand men.

Mr. Forster's talk was naturally of a character which would positively strike home to the fire fighters.

* * * * *

One of our Montreal members, Mr. W. E. Findlay, delivered recently an address upon the Fire Waste at one of the principal clubs in his home city. Our Canadian members are very active in their co-operation. In the conclusion of his Montreal address Mr. Findlay said:—

> In the United States they have awakened to the situation, and the various boards of trade and other leading commercial bodies are doing all in their power to educate the public on this question, and on the remedies which will reduce the disastrous "fire waste," and it is to be hoped that a similar movement will take place in Canada. It is true that our own Board of Underwriters have been doing their best for some time to make the public appreciate the existing evil, but their efforts must be assisted by the co-operation of municipal and commercial bodies if the desired results are to be attained.

* * * * *

President William H. Merrill has been appointed a member of the Illinois State Commission charged with the revision and codification of the building laws of that state authorized by the last session of the legislature. The value of President Merrill's service to the cause of Fire Prevention in connection with the work of this committee is obvious.

* * * * *

Mr. F. H. Cowles is continuing his service as a lecturer on the Fire Waste in the public schools of Oregon. He has gone from his ranch at Medford into the city of Portland for the winter, where he has been agitating certain fire prevention measures as the result of his previous experiences with such matters in New York City.

* * * * *

The Minneapolis Association of Credit Men has recently printed and circulated copies of an address recently delivered on the subject of Fire Prevention by one of its members, Mr. Fred J. Hopkins, before the Minneapolis Retail Hardware Dealers' Association. It is a forceful and well written paper.

* * * * *

President W. H. Merrill is to speak on January 23d at the dinner of the Insurance Society of New York. The President feels that the distinguished courtesy shown to our Association by the Insurance Society at the time of our last annual meeting in New York is sufficient warrant for his making a special journey to the metropolis to speak at the meeting on the 23d.

The City Club of Chicago, through the activity and interest of Mr. Frank D. Chase, recently gave a "Fire Prevention Night" at which two of our members were the principal speakers, Fire Marshal C. J. Doyle, of Illinois, and Mr. William C. Robinson, Chairman of our Committee on Fire Hose. The City Club has a special committee on Fire Protection and Building Regulations, which committee, owing to the efficiency of its Chairman, Mr. Chase, is exercising considerable influence in the municipality.

* * * * *

Mr. Charles E. Eldridge, our indefatigable Kansas member, has recently addressed to the officials of all towns and cities in Kansas the following communication, in which he enclosed a copy of the standard fire department inspection report:—

We most respectfully call your attention to a plan to secure adequate and general inspection of buildings by firemen of the regular fire departments, which system it is believed will bring about a reduction in the fire hazard throughout the buildings of your city, and more especially to the larger value properties of the mercantile section.

A record revised periodically of the condition of every building will not only educate your firemen as to any peculiarity of construction in any building or set of buildings, but will eliminate conditions that are possible for a fire, and which similar conditions have given serious fires throughout the United States.

We submit the form herewith, such as is now being used in cities throughout Ohio, and which is believed to be sufficiently complete and yet simple to bring about the desired improvement for all concerned. We believe a hearty co-operation in this educational movement, now so strongly before this country, will be greatly to your city's interest.

* * * * *

One of our Vermont members, Mr. Henry H. Hickok, has been unusually helpful in agitating for Fire Prevention in his state. Largely through his efforts he secured the appointment of a Fire Prevention Day by the Governor, supplementing the same with the issuance of attractive posters giving the fire losses of the United States together with those of Vermont and the city in which he resides, Burlington. Mr. Hickok has a local agency and has already demonstrated what a local agent can do for the public in the line of education on the subject of the Fire Waste.

* * * * *

Our Nebraska member, Fire Marshal C. A. Randall, delivered one of his clear, practical addresses before the Third Annual Convention of the League of Nebraska Municipalities at Omaha in November. Mr. Randall is unusually resourceful in producing literature on the common hazards for promulgation among the people of his state. He has recently caused to be printed a small card for suspension in the home, containing pledges as to the proper disposition of rubbish, matches and ashes, and the proper care of the ordinary domestic hazards.

Mr. S. Oliver Breed, of Lynn, Mass., our member whose patriarchal appearance always attracts attention at our annual meetings, has encompassed his ninetieth year. He still makes regular inspections at Lynn, and is in excellent health. He is the oldest living Odd Fellow in the United States. His principal activity in the work of the Association has been in agitating for proper cut-off valves in gas service pipes.

* * * * *

President F. R. Bigelow, of St. Paul Fire & Marine Insurance Company, was a speaker at a recent meeting of the Iowa State Fire Prevention Association. Mr. Bigelow has recently returned from Europe and stated that he found a much larger proportion of combustible buildings than he expected to see upon the continent. He regards the low foreign loss ratio as due largely to the common respect to law and to the marked cleanliness of the premises.

* * * * *

We are advised by our active member the National Hardware Association that our Philadelphia member, Mr. Powell Evans, has been reappointed Chairman of the Fire Protection Committee of that organization. The existence of this committee is itself the result of Mr. Evans' interest in fire protection and prevention, and its work could not be in the hands of a more efficient chairman.

* * * * *

Mr. Ira G. Hoagland who has long been active in the work of our Association and who has contributed many estimable papers to our QUARTERLY magazine, has been appointed editor and manager of *Insurance Engineering*, the magazine published by the Insurance Press of New York. Mr. Hoagland's influence and enthusiasm should inject new life into the publication of which he is to be at the helm, and his friends and associates in the N. F. P. A. will wish him the best success in his new adventure.

* * * * *

Secretary Wentworth spoke in November at the annual banquet of the Board of Trade, Fitchburg, Mass., and on December 7th at the meeting of the Credit Men at Syracuse, N. Y.

SYLLABUS

For Public Instruction in Fire Prevention.

To Teachers: No attempt has been made to divide the subject into specific lessons of uniform length. That is the work of the teacher. It is obvious that any of the items may be amplified by the knowledge and ability of the instructor.

As pupils respond most readily to objective teaching, a map of the city in which the school is located should be colored to show the fireproof and the wooden sections. Pupils should be encouraged to make personal inspection of hazardous districts and of desirable fireproof buildings.

They should be taught how to send in a fire alarm, and how to operate a hand chemical extinguisher. Some member of the fire department should exhibit at one of the sessions the mechanism of a fire alarm box, and explain the principle and operation of the chemical extinguisher. Every pupil should know the location of the fire alarm box nearest his home.

The causes of fires may be interestingly taught by suggesting to the pupil that fire reports be clipped regularly from the daily home paper, and that he classify the same as to avoidable and unavoidable fires. One or two Fire Prevention sessions per month in every school will be of great value in the protection of the home.

A.

The Fire Waste: Its Extent.

Average annual American fire loss for ten year period $250,000,000.

- This is $30,000 per hour, or $500 per minute.
- Equivalent of a $5,000 home destroyed every ten minutes.
- Compare similar loss of $250,000,000 per year in wheat, corn or cotton, or funds from U. S. treasury.

Year 1910, a sample average year, with **thirty** fires each involving losses between $500,000 and $1,750,000.

The average annual per capita loss in six European countries is about 33 cents. The average annual per capita loss in the United States is nearly $3. This is $15 per year for a family of five, and does not include the cost of fire departments, which is as much more. The American family of five pays, therefore, $30 per year fire tax.

Great losses occur in the United States from forest fires.

References: Bulletin 418, U. S. Geological Survey: The Fire Tax and Waste of Structural Materials in the United States.

B.

The Fire Waste: Its Economic Significance.

Property burned is gone forever.

- A burned city does not replace itself.
- Fire insurance does not replace lost property.
- Food, clothing and shelter are produced only by human effort, hence labor expended in **replacing waste** is withdrawn from legitimate production for the satisfaction of human needs.

National waste impoverishes the nation, as family waste impoverishes the household.

- The fire waste is not really paid for by insurance companies.
- Fire insurance is added by manufacturers and merchants to the cost of the goods, and whoever buys a loaf of bread, a hat, a coat or a shoe, pays it. The cost of the fire tax is concealed in the price of the goods.
- Every fire is paid for by all the people. Insurance is collected from all and paid to him who has a fire; hence the man who has a fire intentionally or unintentionally takes money from the pockets of his neighbors. Fire insurance is an assessment upon all to pay to one; hence every fire makes every man's struggle for a living harder by compelling him to spend for his neighbor's waste what he might otherwise spend for his own comfort.

References: National Fire Protection Association publications:

(1) Secretary's address: Significance of the Fire Waste.

(2) Address of Secretary of Interior, U. S.: The Fire Waste.

C.

The Fire Waste: Causes and Prevention.

Fires Start From

Lack of Cleanliness

- Rubbish heaps are fire breeders. Fires start in them and are fed by them. A clean city will have few fires.
- Attics and cellars should be kept free from combustible accumulations.
- Ashes carelessly disposed against wooden fences or other combustible surfaces.
- Burning trash or autumn leaves too near buildings.

Smoking

- The careless use of pipes, cigars and cigarettes causes countless fires.
- Smoking in factories, mills, warehouses and shops, stables, garages, etc., should be absolutely prohibited.
- Sawdust should never be used in cuspidors.

Matches

- The match is designed to start fires, and it does. A single match may cause the burning of a city. Most fires are of the same size when they start.
- A thoughtful husband or father will have no matches in his home except those which light only on the box. Such matches, if accidentally dropped or secured by young children, cannot be ignited on any ordinary surface. Hundreds of baby children are burned to death every year, playing with the "strike anywhere" match.
- No match which can accidentally ignite under foot, or be ignited by rats or mice, should be allowed in home, store or factory.

Lighting Devices

- Defective electric wiring: All wiring should be done by competent electricians only, and inspected before current is turned on. Electric light bulbs should never be covered by cloth or paper shades or decorations.
- Exposed gas jets: Curtains and draperies may be blown against gas jets by draughts from open windows. Adjustable gas brackets should be guarded by stops, and the flame enclosed in wire globes.
- Kerosene lamps should be kept scrupulously clean.
- Private gasolene vapor or acetylene gas lighting plants should be frequently inspected and kept in strict conformance with safety requirements.
- Candles should never be taken into closets or other places where they may ignite inflammable materials.

Heating

- Defective chimneys and flues: Public authorities should certify to the proper chimney construction of every house. Builders can easily cover up dishonest intent or criminal negligence in chimney building.

Fires Start From

Heating

Neglected furnaces: Fires should never be relighted until the furnace is overhauled. Pipes rust during the summer and may deliver sparks to the cellar. Smoke pipes should be taken down in the spring as the passage of moist air through them rusts them rapidly.

Overheated stoves: Stoves often get red hot when filled with fuel and left with drafts open. Clothes hung close to dry or other nearby material is easily ignited. A stove is a receptacle for fire, and should not be neglected.

Gas and oil stoves should be kept scrupulously clean and free from leaks.

Explosives, Gases and Oils

The commercial storage, handling and use of explosives, inflammables and combustibles should be regulated by public authority in the interest of the common safety.

Gasolene, naphtha and similar volatiles for domestic cleaning should be used always in the open air where possible, and by daylight only, and never near any open flame.

Oily rags or waste, used in furniture polishing or any sort of cleaning, should be burned at once after using, as certain oils ignite spontaneously.

Holiday Causes

Fireworks and Fourth of July pyromania should be abolished, and an Independence Day with sane and interesting civic exercises substituted.

Flimsy inflammable Christmas decorations, cotton as a substitute for snow, and all similar fire breeding material, should be discarded. Better and safer things can easily be found.

Carelessness

The European peoples, reading of our stupendous fire waste, are puzzled to know if we are a nation of incendiaries or a nation of children playing with matches. We are neither; but we are very careless and our careless habits must be corrected.

Individual responsibility for fires must be emphasized by fire inquests held by fire marshals in all the states. In France he who has a fire must pay any loss resulting from it to his neighbors. This is very educative.

Fire prevention is as important as fire extinguishment. Fire departments should prevent fires as well as extinguish them. All fire departments should make regular inspections, keeping cities free of rubbish and other fire-breeding dangers.

State building codes should eventually regulate all building construction so that many careless habits in building may be eliminated, and proper attention given to the fire hazard in homes, shops, mills and factories.

Fires are Spread by

Wooden Construction

American towns and cities are built largely of wood. Foreign cities are not.

Conflagrations are unavoidable where wooden buildings are erected in close proximity. Wind-driven fires spread rapidly. Conflagrations are never extinguished with water. They burn themselves out if not stopped by fire walls or incombustible barriers of some sort. As long as the American people build of wood, our fire tax will be a heavy economic burden and handicap to the general prosperity.

Combustible Roofs

Wooden shingles are the principal American conflagration breeders. When dry they ignite like tinder when flying brands or sparks alight upon them. Once a shingle roof is on fire the draught of the flame tears off the light shingles and carries them to other roofs to be ignited in turn and in their turn to furnish new flying brands.

All roof coverings should be incombustible, or at least slow-burning. The use of wooden shingles should be entirely abandoned, as they multiply the fire danger of the wooden house.

Unprotected Window Openings

Conflagrations in brick, stone and concrete sections of cities are only possible because of unprotected window openings. A stone or concrete building is itself a fire wall if the fire can be kept out of it.

Any city not built of wood can abolish its conflagration dangers by replacing its wooden window frames and thin glass by metal window frames and wired glass, or equipping the same with standard fire shutters. Any good fire department can then extinguish a fire in the building in which it originates. An unusually hot fire might burn out of one building into the next, but a conflagration could not get started.

It is the frequent conflagrations in the business districts where the commercial values are greatest (and where they might easily be guarded as above suggested), which make the fire tax in the United States so enormous.

References: National Fire Protection Association publications: Bulletins and Fire Reports.

Factories and Their Fire Protection (pamphlet).

Private Fire Departments and Fire Drills (pamphlet).

Dangers and Chemistry of Fire; published by Fire Marshal's Office, Columbus, Ohio.

Firebrands; a story for children, by Frank E. Martin and George M. Davis. (Boston: Little, Brown & Co.)

Individual Responsibility for Fires in France.

Under all American efforts to check the fire waste now lies the growing conviction that no real progress can be made until the man who has a fire ceases to be regarded as an unfortunate and is looked upon as a public offender. Individual legal responsibility for loss by fire seems a drastic corrective to the ordinary American anarchist who believes his neighbors can look out for themselves no matter how unneighborly his own acts may be; but such restraint must undoubtedly be the avenue through which our absurd number of fires may be curtailed. If every down-town building occupant in New York were financially answerable for any loss to his neighbors caused by fire in his property, there would be a stampede for the protection of window openings, and the conflagration hazard of the metropolis would quickly disappear.

There is nothing revolutionary in the idea that an individual should be responsible to others for his acts. In other circumstances such phrases come from American lips with sufficient glibness. It is in the application of the principle to fires that it seems revolutionary.

It does not rest with Americans, however, to make the primary application of this principle in the matter indicated, for the French have long so applied it with most admirable results. There are no special laws in France relating to fire inquests, yet an inquiry by the police is made into every fire in cities and towns, and in the country districts by the *gendarmerie*.

The responsibility of a man for fire damage to his neighbor lies not in any special enactment, but in the interpretation of two short sections of the Code Napoleon, which code of laws prevails especially in France and Belgium and which forms the basis for the modern law in most Latin countries. The sections referred to are as follows:—

Article 1382: Every person is responsible and liable for any acts of his by which any other person has or may have sustained any loss, damage or injury.

Article 1383: Every person is responsible for any loss, damage or injury caused by his own act, carelessness or negligence.

This responsibility, as it relates to fires, is called in France the *Recours des voisins*, or neighbors' risk. It is universal and applies to landlord and tenant alike. As applied to fires, these articles mean that if a fire starts in any premises through gross carelessness or culpable fault all damages done to neighboring property by that fire must be made good. There is no limit to this liability, which may extend to an entire block

in case of conflagration. The only point in the application of the law by which such an offender may escape is that the burden of proof lies with the neighbor making claim. The latter must be able to prove, before he can recover damages, that the fire was directly due to gross carelessness, culpable neglect or mischievous intent.

There are two articles in the French code which apply specifically to fires. These undoubtedly originated with the landlords. These articles are as follows:—

Article **1733**: The tenant is responsible for a fire on his premises unless he can prove that the fire was caused by something beyond his control, by some fault in building, or that the fire was communicated by a neighboring building.

Article **1734**: If there are a number of tenants, all are alike responsible unless they can prove that the fire caught in the apartment occupied by one of them, in which case he alone is responsible, or unless some of them prove that the fire did not begin in their apartment, in which case they are not responsible.

The responsibility here indicated is called the *risque locatif*. The tenant having a fire is responsible to the landlord for loss of rent; not only his own rent, but that of other tenants.

The presumption always is that the fire was caused by the act or neglect of the tenant, and the onus of proof rests upon him to show that it originated from some structural defect or from some cause beyond his control before the landlord can be held responsible. A tenant, therefore, must suffer not only the loss occasioned to his own property, but likewise that caused to his landlord's as well as to his neighbor's, by a fire originating in his (the tenant's) own premises, unless he can prove to the satisfaction of a court of law that the accident was occasioned by some defect in the building or from some other cause over which he had no control, in which event the entire loss, both on building and contents and for damage done to neighbor's property, falls upon the owner of the building in which the fire originated.

It is obvious that the law is very much in favor of the landlord; for all the "proving" must be done by the tenant. He is assumed to be guilty; he must prove he is not, and before he can recover any loss of his own he must prove the landlord's culpability in faulty construction of the building or neglect in its proper upkeep. In practice the cases in which a tenant is able successfully to escape his liability are very rare (he is assumed to be guilty), while the landlord's liability (he is assumed to be innocent) is not easily established.

It will be readily seen that the existence of such laws as those above given is a very potent corrective of careless habits; while a secondary effect is to create a form of fire insurance not common in America.

In France a tenant usually insures by one policy the following items: 1, His own property; 2, The *risque locatif*—the risk of responsibility for damage to the building; 3, *The Recours des voisins*—the risk of responsibility for damage to property of his neighbors. A landlord insures in one policy the following items: 1, His own property; 2, *The Recours des locataries*—his responsibility for damage to the property of

tenants; and 3, *Recours des voisins*—his responsibility for damage to the property of his neighbors.

While it is improbable that such laws as obtain in France will receive American enactment in the near future, it is yet certain that the growing popularity of the office of fire marshal in the states of the union is an indication of the general desire to fix personal responsibility for fires. Such inquests as are made by the fire marshal's office must speedily demonstrate that over fifty per cent of American fires are due to gross carelessness, and the curbing of this carelessness by statutes fixing responsibility would seem to be the logical next step.

Comparative Statistics of Fire Loss.

AMERICAN AND FOREIGN.

A careful analysis of the last report of the Committee on Statistics, of the National Board of Fire Underwriters, discloses some very interesting facts. The per capita loss for 299 of the 301 cities having population of 20,000 or over, was $2.39, being an increase of twenty-five cents over a similar group of cities for 1909. The total per capita loss of the whole country was estimated at $2.33 for 1910. In a group of the twenty-seven cities of the country, having a population of 200,000 or over, Minneapolis stood the highest with a per capita loss of $6.60. Cincinnati came next with a per capita loss of $5.24, and Boston was third with a per capita loss of $5.15. The average per capita loss for this group of twenty-seven cities was $2.32 and the per capita loss in fourteen of these cities was greater than the average. The city in this group having the smallest per capita loss was Indianapolis, which was $1.18. Cleveland came next with $1.19, and Washington, D. C., had a per capita loss of $1.20.

In a group of seventeen cities having a population of 300,000 or over, the average per capita loss was $2.36. The same three cities hold their relative position as regards largest per capita loss, as in the last group described. Cleveland holds minimum place here, with Washington next and Baltimore third from the lowest, with a per capita loss of $1.29. In this group eight cities have a greater per capita loss than the average for the group.

In a group of ten cities having a population of 400,000 or over, Boston has the largest per capita loss, Chicago comes next with a per capita loss of $2.76, and San Francisco third with $2.51. Cleveland again makes the best showing in this group, Baltimore coming next and Philadelphia third from the lowest, with a per capita loss of $1.67. St. Louis closely followed with a per capita loss of $1.68. The average per capita loss for this group is $2.14, half of the cities being above the average.

The largest per capita loss of any city reporting was in Vicksburg, Miss., a city of 20,814, which had a per capita loss of $18.60. Petersburg, Va., with a population of 25,000, reported a per capita loss of $14.85, and Portsmouth, Ohio, with a population of 23,481, had a per capita loss of $10.81. The smallest per capita loss was enjoyed by Richmond, Ind., a city of 22,324, which had a loss of eighteen cents. Parkersburg, W. Va., a city of 17,842, came next with a loss of nineteen cents; Lebanon, Pa., with a population of 19,240, had a per capita loss of twenty-one cents; Newport, Ky., and Altoona, Pa., having populations of 30,309 and 52,127, respectively, each had a per capita loss of twenty-four cents.

The per capita losses in a few of the states for the cities of 20,000 or over reporting, were as follows:—

Massachusetts, twenty-nine cities	$2.77
Connecticut, ten cities	2.08
New York, twenty-five cities	1.95
New Jersey, sixteen cities	2.42
Pennsylvania, twenty-five cities	1.54
Virginia, eight cities	3.41
Texas, nine cities	4.10
Ohio, twenty-one cities	2.48
Indiana, twelve cities	1.49
Illinois, seventeen cities	2.68
Wisconsin, ten cities	2.28
Iowa, ten cities	2.10
California, ten cities	2.78

A classification of the cities according to the amount of the per capita loss into the following fifteen groups, is of interest.

Per Capita Loss.	No. of City.
Less than 25 cents	5
25 to 49	18
50 to 74	22
75 to 99	32
1.00 to 1.49	56
1.50 to 1.99	36
2.00 to 2.49	34
2.50 to 2.99	23
3.00 to 3.49	8
3.50 to 3.99	13
4.00 to 4.99	18
5.00 to 5.99	14
6.00 to 7.99	12
8.00 to 9.99	3
10.00 and more	4

Relation of Number of Fire Alarms to Population.

The city having the greatest number of fire alarms per population was Meridian, Miss., a city of 23,285 people, in which there was an alarm of fire for every eighty-two of population. Waco, Texas, with a population of 26,425, came next with an alarm for every ninety-two people. Newton, Mass., had one alarm for every ninety-four of population, and Concord, N. H., one alarm for every ninety-six. All other cities had less than one fire for every one hundred of population.

The city having the least number of fires was Norristown, Pa., which has a population of 27,875 and a record of one fire for each 1,163 of population. Oshkosh, Wis., a city of 33,062 people, had one fire for each 1,136 people. Wilmington, Del., reported 67 fires for each one thousand of population during a period of ten months only, and Hazelton, Pa., 71 for a period of nine months only. With three exceptions, every city among all those which reported, had a record of more than one fire for every one thousand of population. Only sixteen cities besides these just mentioned had a record of less than one fire for every five hundred of population.

In the twenty-seven prominent cities previously mentioned, Kansas City had the greatest number of fires per population, or one alarm for every 111 people. St. Paul had one alarm for every 124, and Minneapolis one for every 126 of population. The best record from this point of view among these cities was held by New Orleans, which had one alarm for every 490 people, and Philadelphia came next with one alarm for every 417 of population.

There appears to be no direct relation between per capita losses and number of fires. Vicksburg had one fire for every 577 of population, while Petersburg had one fire for every 238 of population. Richmond had one fire for every 178 of population, while Lebanon had one fire for every 740 of population. Altoona and Newport, which enjoyed the same small per capita loss, had one fire for every 124 and 225 of population, respectively. Cincinnati had one fire for every 214 of population, and St. Louis one fire for every 201, the per capita loss being widely different.

A Study of Fires in Foreign Cities.

England. In ten of the largest cities, with one exception, reporting the per capita loss, Southampton, with a population of 127,157, had the minimum loss, which was nine cents, and Birkenhead, with a population of 122,232, had the maximum loss of ninety-nine cents. The exception noted was Bath, with a population of 50,000, which had a per capita loss of $2.50. The average for the country was forty-four cents. The fire loss of London was not reported.

Ireland. Belfast, with a population of 349,180, and Dublin, with a population of 308,500, had a per capita loss of forty-six cents and forty-four cents respectively.

France. Among eight of the largest cities, Marseilles, with a population of 517,498, had a loss of $3.79; Roubaix, with a population of

120,115, had a loss of $1.65, and Bordeaux, with a population of 257,471, had a loss of $1.12. The remaining cities varied from Calais, of 80,000 population and a loss of ten cents, to Lyons, of 472,144 population and a loss of seventy-eight cents. Paris has a population of 2,763,393 and had a loss of forty-three cents. The per capita loss for the country was ninety-two cents.

Norway. Christiana, which has a population of 244,000, reports a per capita loss of twenty-five cents.

Germany. The greatest per capita loss among thirteen of the largest cities was forty-two cents, which occurred in Karlsruhe, a city of 133,953. Metz, with a population of 72,000, had a per capita loss of one cent, and Berlin, with a population of 2,064,153, had a per capita loss of four cents. The per capita loss for the country was nineteen cents.

General. No foreign city reported more than 2.48 fires per one thousand of population, and the average for the whole was one fire for every 1,011 of population. The most striking feature of these statistics is the almost universal lack of frame buildings or fires in buildings of this class. Berlin had the largest number, which was forty-four, while 1,795 fires occurred in brick or stone buildings. On the other hand, in the United States the city where the number of fires occurring in brick buildings was greater than the number occurring in frame buildings was found to be rare. Generally the number of fires occurring in frame buildings is found to be greatly in excess.

It is to be regretted that their efforts to secure reliable statistics of the number of lives lost by fire were so unsuccessful that no such tabulation was presented in their report, nor could they procure any accurate data of the number of incendiary fires.

Be Careful.

(Produced by the *Brooklyn Eagle* after an examination of the report of the National Board of Fire Underwriters on the condition of the Fire Alarm service in the Borough of Brooklyn, December, 1911.)

Don't touch the matches, Mabel,
Or spill them on the floor,
Don't jog the shaky table,
Where the lamp is, anymore;
Don't let Pa dump his ashes
From his pipe in his old way,
For he does not know how rash is
Such carelessness to-day.

Be careful of the gas stove,
Don't let it puff blue flame;
Electric lights need watching nights,
Our wise alarmists claim;
Don't mess with tallow tapers
Among that attic junk.
For I notice by the papers
Our Fire Department's punk.

The papers say headquarters
Is in a direful way;
That news of fires is flashed by wires,
Which may go wrong some day;
We may need fire protection
When headquarters can't know,
So don't give Baby matches,
And turn the oil lamps low.

"Unjust To Wooden Shingles."

(Editorial in the Mississippi Valley Lumberman, Minneapolis, Minn., November 10, 1911.

In the course of an address at the Minnesota Fire Prevention Day meeting at St. Paul, this week, Franklin H. Wentworth, of Boston, made the statement, "Wooden shingles are not a roof covering; they are a crime."

We believe it is a greater crime for any man to go about the country creating prejudice against a great industry by making statements which cannot be substantiated or supported by facts.

Mr. Wentworth speaks particularly of the great fire at Chelsea, Mass., where, in a hurricane of wind, burning shingles were carried long distances and set fire to other structures. Since the occurrence of that fire at Chelsea, the illustration has been frequently used. It is easy enough to counter with the statement that in the Baltimore and San Francisco fires the wind carried the flames at such a pace and with such force that neither steel, iron, brick, stone or concrete could withstand them. They are exceptional cases, just as was the Chelsea fire, and no criterion on which to base judgment.

It is to be presumed that the fire insurance companies have the best knowledge of fire risks, since this knowledge means dollars and cents to them, and it is their business to know what are the greatest risks. If wooden shingle roofs are the great menace Mr. Wentworth contends they are, we should expect the insurance companies to make higher premium rates on structures with that kind of roof coverings. What are the facts?

Dwelling houses in cities, where more than ninety per cent of the roofs are wooden shingles, carry **the lowest insurance rates** of any risks written by insurance companies. Reliable information from insurance companies shows that **less than three per cent** of dwelling house fires originate on shingle roofs. **Premium rates are lower** on brick and concrete houses with shingle roofs than on frame houses with tile, slate or other non-combustible roof coverings.

We never yet saw a dollar which could not make an argument satisfactory to itself.

Rubber-Covered Electric Wires and Cables.

New Code Specifications Now Operative.

For a number of years all those interests concerned with the installation and use of rubber-covered wires and cables have realized that the specifications of the National Electrical Code for wire coverings were not of such a character as necessarily to insure the production of a satisfactory insulation.

For a long time the Electrical Committee of the National Fire Protection Association has been wrestling with this problem. A number of sub-committees have been, for several years, occupied with the various details of improved specifications. After innumerable conferences with the manufacturers of rubber-covered wire, specifications were finally agreed upon calculated to improve the whole line of wire coverings.

It was realized that the ordinary high potential and galvanometer tests, which for years were conducted in the attempt to secure the conformance of the product to the Code as then written, were not sufficient to guarantee the integrity of the product; therefore the committees, in working out the new specifications, included not only physical tests of the rubber compounds but chemical analysis as well, beside making provision for tests of the wire after certain periods had elapsed subsequent to its manufacture.

All differences having been finally adjusted, the new specifications for wire coverings were adopted unanimously at the meeting of the Electrical Committee in New York, in March, 1911.

It remained for the Electrical Committee to render any further service possible in the perfection of proper tests of the new Code wire in order that its general use might be speedily promoted. A sub-committee has therefore been appointed to assist in reconciling all differences which may arise in the administration of the wire inspection service to be carried on at the factories by our active member the Underwriters' Laboratories, Inc. The resolution of the Electrical Committee establishing this sub-committee has been formally endorsed by the Executive Committee of the Association by adoption of the following resolution:—

RESOLUTION OF EXECUTIVE COMMITTEE NATIONAL FIRE PROTECTION ASSOCIATON ENDORSING RESOLUTION OF THE ELECTRICAL COMMITTEE REGARDING SUB-COMMITTEE ON RUBBER-COVERED WIRE.

Having before us the resolution of the Electrical Committee, regarding its appointment of sub-committee on rubber-covered wire, be it resolved that the Executive Committee hereby endorses said resolution.

Resolution of Electrical Committee.

Resolved: That the sub-committee on rubber-covered wire of this committee consist of six members, three being representatives of the Underwriters' Laboratories, and three being representatives of the manufacturers of wire, and be it further resolved that the aforesaid three representatives of the manufacturers of wire shall be nominated by the manufacturers subscribing to the Underwriters' Laboratories' wire inspection service.

The Wire Inspection Bureau, formerly operated by the rubber-covered wire manufacturers, has been abolished. All factory inspections are henceforth to be made by the Underwriters' Laboratories, Inc., which is to furnish inspection stamps to appear upon the tags attached to wire shipments to indicate that the coils have been properly tested by the wire manufacturers under the specifications of the revised Electrical Code.

All the principal factories of the country are now turning out the new Code wire. The rubber-covered wire manufacturers have agreed that all such wire will, after January first, be duly tested under the new specifications and will bear the identifying label of the Underwriters' Laboratories, Inc., as evidence of its conformance with these specifications. It is understood that a reasonable length of time will be allowed after this date for the disposal of old Code wire not bearing this label and representing bona fide stock or contracts placed or taken prior to January 1, 1912. This is, however, with the assumption that such stock or contracts of old Code wire will be entirely disposed of by July 1, 1912, and that after such date only wire manufactured under the 1911 specifications of the National Electrical Code will be accepted as standard by inspection authorities having jurisdiction. We are advised that the Electrical Departments of the cities of New York and Chicago have already made rulings demanding the use of the new Code wire after January first. Following is the notice promulgated by Mr. William Carroll, electrician, city of Chicago, covering new, 1911, Code wire:—

Please take note of the following change in the specifications for rubber-covered wire, a copy of which is enclosed.

After January 1, 1912, all wires in sizes from No. 14 to No. 4-0 B. & S. gauge, must comply with the new specifications.

After July 1, 1912, all wires in sizes from 250,000 circular mils up, must comply with the new specifications.

The following exceptions will be made: On all contracts signed previous to the date of the issuance of this notice (September 25, 1911), wire complying with the "municipal specifications" may be used, provided all such contracts are listed with this department within fifteen (15) days.

Recognizing the serious hazards incident to electric wiring which the use of properly made and insulated conductors will largely help to eliminate, all members of the National Fire Protection Association are urged to co-operate with the efforts of our Electrical Committee to henceforth exclude from use all wires and cables except those manufactured under the specifications of the new Code.

Making an Electrical Code for New York City.

By Hubert S. Wyncoop (Member N. F. P. A.)

Electrical Engineer, Bureau of Electrical Inspection, City of New York.

If the plumber or the gas-fitter neglects his work, water, sewer gas or illuminating gas assails one or more of our senses; and steps are taken promptly to rectify the error before serious damage is done. If the electrician scamps his job, none may be aware of it until a disastrous fire occurs or some person is injured by electric shock.

Again, if the plumber or the gas-fitter makes his joints and fittings tight and provides the proper drips and vents, he has taken sufficient precautions to insure public safety. Not so, however, with the electrician; for the latter must be continually on his guard against the doing or omitting of those things which experience teaches must be done or omitted in order to avoid the presence of a fire or life hazard.

Hence the necessity for an electrical code.

In the early eighties the insurance interests, becoming alarmed at the prevalence of fires whose origin could be attributed only to the then newly exploited electric lighting systems, issued rules for the guidance of their inspectors, and announced that compliance with these rules on the part of the insured would secure the lowest rate for electrically equipped risks. The insurance interests were grouped territorially and each group established its own set of rules, which not infrequently conflicted with the rules of another group, so that more or less confusion reigned, and the "Underwriters' Rules" met with only a half-hearted reception at the hands of the lighting companies, the contractors and the public at large.

Municipal authorities were very slow in assuming control of the situation by establishing a public electrical inspection service. For years, therefore, the Underwriters worked unaided, accomplishing a very large amount of very valuable work, solely through their appeal to the self-interest of the insured.

The very fact that the Underwriters were obliged to rely upon self-interest to secure the rectification of dangerous electrical conditions, forbade any mandatory action on their part, and it was necessary for them to inaugurate widespread campaigns to arouse public interest in the proper control of electrical construction. So successful were these campaigns that no one questions to-day the dictum that electrical inspection is a function of the police power of the commonwealth.

Having incited municipal action, the next problem was how to control it so that the supervision might be intelligent and painstaking. Each

municipality set out merrily on its inspections, using its own set of rules, which might or might not agree with one of the sets put forth by the Underwriters' groups, and, temporarily, the cure was worse than the disease. At the period of which we are treating it was possible for a shrewd contractor to "put over" almost any kind of electrical construction, and put an expert on the stand who would prove by somebody's rules that it was the very best, the very last word in safe wiring.

While the need for uniformity was keenly felt, it was not until 1895 that a national conference was held. All parties at interest met at New York and formed an electrical committee under the auspices of the National Board of Fire Underwriters, which proceeded to the adoption of the National Electrical Code, which, as amended and elaborated from time to time, has become the recognized standard of the electrical inspection service throughout the United States and Canada. This code is revised biennially by the Electrical Committee of the National Fire Protection Association. The catholicity of the committee is shown by the interests having representation through its membership, as follows:—

The Fire Underwriters.
American Institute of Electrical Engineers.
American Electric Railway Association.
Electrical Supply Jobbers' Association.
National Electric Contractors' Association.
National Electrical Inspectors' Association.
National Electric Light Association.
Various municipalities.
The Underwriters' Laboratories.

In order that everyone at interest may have an opportunity of presenting his views, the Electrical Committee, upon the completion of its sittings, holds an open convention extending over several days, and any person is entitled to the privileges of the floor. The final decision is reached in each case by vote of the open meeting; and it sometimes happens that the Electrical Committee cannot support its recommendations strongly enough in the face of convention opposition, and is voted down.

For years the city of New York played a lone hand in the matter of electrical rules. Even when it employed the phraseology of the National Electrical Code, the numbering was not retained, and the sense of agreement was lost. The result was a double standard of inspection in the largest city in the country, a contradiction of requirements and the most attractive opportunity to play one inspection authority against the other —an opportunity that was not by any means neglected.

The Commissioner of Water Supply, Gas and Electricity of the city of New York is the official charged with the duty of conducting the electrical inspection service. Several years ago he designated three of his engineers to act as an advisory board in electrical matters. A revision of the rules was a matter of pressing moment; and it was unanimously decided to recommend the adoption of the National Electrical Code as the

standard, departure therefrom to be made only where local laws or conditions might render such departures necessary or desirable. It was hardly to be expected that a code developed as the National Electrical Code had been, by vote of the country at large and with the Underwriters as the dominant element in its adoption, could be accepted absolutely intact by any municipality; but our engineers set their faces strongly against any alteration that could not be shown to be required by local conditions.

Furthermore, before any actual steps were taken looking toward the adoption of a new set of rules, a working agreement was entered into with the New York Board of Fire Underwriters which secured to the city the valuable services of the latter's engineers, who became members of an enlarged Advisory Board. The breadth of local view which has thus been brought to bear upon our recommendations has, we believe, been of great advantage.

The wear and tear on the engineers has not been inconsiderable. At the outset we agreed that no recommendation should go forward unless it had received unanimous approval. I have vivid recollections of a five-hour session devoted principally to half a dozen lines out of the seventy-four hundred which compose the Code. But this effort was well worth while, for if we could not convince each other, how could we support our recommendations before the public?

Our new Code, then, starts out with the following preamble, to which all of the engineers have subscribed:—

"The following rules are based upon the requirements of the National Electrical Code, departure from which has been made only when local laws or conditions have rendered certain modifications necessary or desirable. Wherever a departure occurs, it is indicated by a bracketing of the portion of the National Electrical Code omitted, and the insertion immediately thereafter of the city's substitute requirement, if any, in italics."

The book as issued enables any person to determine at a glance the general requirements of the electrical inspection service throughout the United States and Canada, and also the special requirements for this city.

The accentuation of these differences, far from inciting acrimonious discussion, will lead in the end toward greater uniformity. Whether it is to be expected, or whether it is even to be desired, that finally the Electrical Code of the city of New York and the National Electrical Code should coincide, the city has at last set its face in the right direction and is working with, rather than against, kindred interests.

Coincident with the adoption of the new Code, we are developing a uniform and fairly rigid compliance with its requirements, treating it so far as practicable as if it were a set of specifications. The advantage to be derived from this is the placing of all electrical contractors on a common footing, so far as the character of the construction on which they submit bids is concerned. In the past there has been too great a tendency in all quarters to allow a contractor to substitute methods of his own, on

the "just as good" plan of the conventional druggist. Our inspectors are instructed to report all departures from code requirements; and when the contractor appeals he is obliged to show the engineers *why* he asks for an exception; and all "just as good" arguments are shut off.

This does not mean that our engineers are unwilling to recommend granting exceptions, when such exceptions are shown to be necessary or desirable. We recognize very clearly that an inflexible set of rules would have a tendency to throttle electrical development.

Mechanical Refrigeration.

By Alex. M. Blumenthal (Member N. F. P. A.)

Prefacing this article is for the sole purpose of inducing those readers not familiar with the process of mechanical refrigeration to forget for the present the prejudices they have had and bear with the writer until they have followed through the cycle of operation, and are convinced that the hazards incidental thereto are not quite as serious as they generally supposed.

This prejudice is due largely to the oft repeated glamour **"Ammonia Explosions"** in bold headlines of our daily press, when they report on fires in places where refrigerating machinery is used, lending sensationalism to an otherwise commonplace report of a fire by their artificial, melodramatic, descriptive features.

In the dreadful fire at the Chicago Stock Yards, in December, 1910, where Fire Chief Horan and twenty-one of his brave men were killed, all the daily papers attributed the fearful loss to ammonia explosions, when in fact there was no ammonia whatever in the building, the refrigeration being furnished by a brine system, supplied with cold brine from a plant one hundred and fifty feet away.

At the time of the fire in the Monarch Cold Storage Company's Warehouse "B," in Chicago (March, 1911), the papers again gave full and detailed accounts of repeated explosions of ammonia tanks, whereas no explosions occurred, unless they were such as are occasioned at times by superheated air in a confined space. The fire being confined to the upper three floors, permitted the operation of the refrigerating machinery, located in the basement, for several hours after the fire started, and the system had been pumped dry of ammonia before any of the pipes on the upper floors were ruptured.

To be sure there are some hazards to be found in connection with a refrigerating plant, but as will be shown later, they are over-estimated and most of them are common to almost any kind of machinery and especially machinery of the compressor type. Notwithstanding this fact, whether the fire is due to the machinery, careless use of matches or candles, or what not, the fact that it occurs in a plant where refrigerating apparatus is used,

immediately casts a veil of mystery over all, and we are sure to hear all about the disastrous **ammonia explosions.**

To refrigerate means to cool, an act whereby the temperature of a body is reduced or maintained below that of the outside atmosphere. This is accomplished by a process in which heat is absorbed, thereby producing the condition called cold, but which in fact is the absence of heat, as darkness is the absence of light.

This may be accomplished by any one of four methods; viz., by the transfer of heat from warmer to cooler bodies, as applied in the brine system; by the chemical action of so-called freezing mixtures, or by that process wherein any one of a number of salts goes into solution, as is widely used in the manufacture of iced cream, where rock salt and ice are used; by the adiabatic expansion of gases, as used in the now almost obsolete air compressor systems, where air at a high pressure is allowed to expand at lower pressure in a cylinder of an air engine, the expanded and cooled air being used as the refrigerating medium; and lastly, the most important of all, by the absorption of heat, when a solid is tranformed into liquid or a liquid into a gas, a physical law upon which the science of refrigeration is based.

The latter system is the one we will have in mind, — the expansion of a liquid, having a low boiling point, into a gas, the heat being absorbed through the coils of pipe in which the gas is allowed to expand. An extreme illustration would be the change in the steam boiler, where water passes off into steam, the necessary heat being supplied by the combustion of fuel.

A simple illustration, as used in the laboratory to show the absorption of heat by the evaporation of a liquid, is to place a watch crystal or small beaker containing a small quantity of carbon disulphide upon a few drops of water on a board, and assist the evaporation of the CS_2 by blowing same with a hand bellows. If the evaporation is rapid enough, the water under the beaker will be found to be frozen, so that the beaker adheres to the board.

Physical Properties of Gases.

Before we proceed further, let us consider a few of the truths regarding gases and their properties.

Liquefaction. If sufficient pressure be applied to any gas and the temperature be sufficiently lowered, all gases can be compressed to a point of liquefaction.

Heat of Compression. When a gas or vapor is compressed, the energy or work spent to accomplish the compression appears in the form of heat, as can be easily noticed in operating a bicycle pump. This heat is not due to friction alone, as it may be demonstrated by operating the pump with no back pressure; *i. e.*, exhaust port of pump wide open. In this case the heat due to friction is hardly perceptible.

Absorption of Heat. When a liquid that has a low boiling point is allowed to pass into a space having a lower pressure, the liquid will expand

into a gaseous state, provided there be an amount of heat present equivalent to the heat of compression.

Critical Temperature and Pressure. There appears to exist for each gas a temperature above which it cannot be liquefied, no matter how high the pressure, which temperature is termed the critical temperature, and the pressure which causes liquefaction at or as near below the critical temperature as possible, is called the critical pressure; *i. e.*, ammonia gas becomes a liquid at 28.6° below zero F. at atmospheric pressure, and at 65° F. when under 103.3 pounds pressure. At about 266° F. it requires about 1725 pounds pressure (about 115 atmospheres) to liquefy it, which pressure is the critical pressure, for 266° F. is the critical temperature, above which it cannot be liquefied, no matter how high the pressure. Carbon dioxide has a critical temperature of 89° F., and a critical pressure of 75 atmospheres, or about 1125 pounds.

Media Used in Refrigerating Systems.

The two gases used almost exclusively at the present time in this country are ammonia (NH_3) and carbon dioxide (CO_2), commonly though incorrectly called carbonic acid gas, the latter being used only to a limited extent in the smaller and private installations. Other media that have been used in the past and abandoned are sulphur dioxide (SO_2) ethyl chloride (C_2H_5Cl) and Pictet's fluid, a mixture of carbon dioxide and sulphur dioxide. These and the air system were used abroad to some extent; but others, such as sulphuric ether, naphtha, gasolene, rhigolene, and other hydro-carbons, were used only in an experimental way. There is also a vacuum system possible in which water is used, vaporization being accomplished by means of a vacuum and the affinity that sulphuric acid has for water.

REFRIGERATING SYSTEM.

We will only consider the ammonia system for the present, it being typical of any compression system, except as to pressure, which in the carbon dioxide system is very much higher.

Ammonia is selected as the universally used medium of refrigeration on account of its low boiling point (—28.6° F.), its high latent heat of vaporization and its non-corrosive effect on iron and steel. The refrigerating plant consists of two main parts: —

1. The liquefying plant, where the gas is liquefied by means of either of two systems, the compression or the absorption system.

2. The heat absorbing or refrigerating apparatus, consisting of the expansion coils, whether placed directly in the cooling rooms, or in the brine tank or at a fan, bearing in mind that the expanding gas in these coils must absorb heat from their surroundings.

COMPRESSION SYSTEM.

This system consists essentially of the following apparatus: —

(See Diagram No. 1)

A. Motive power to drive compressor: steam, electric, gas, water power, etc.

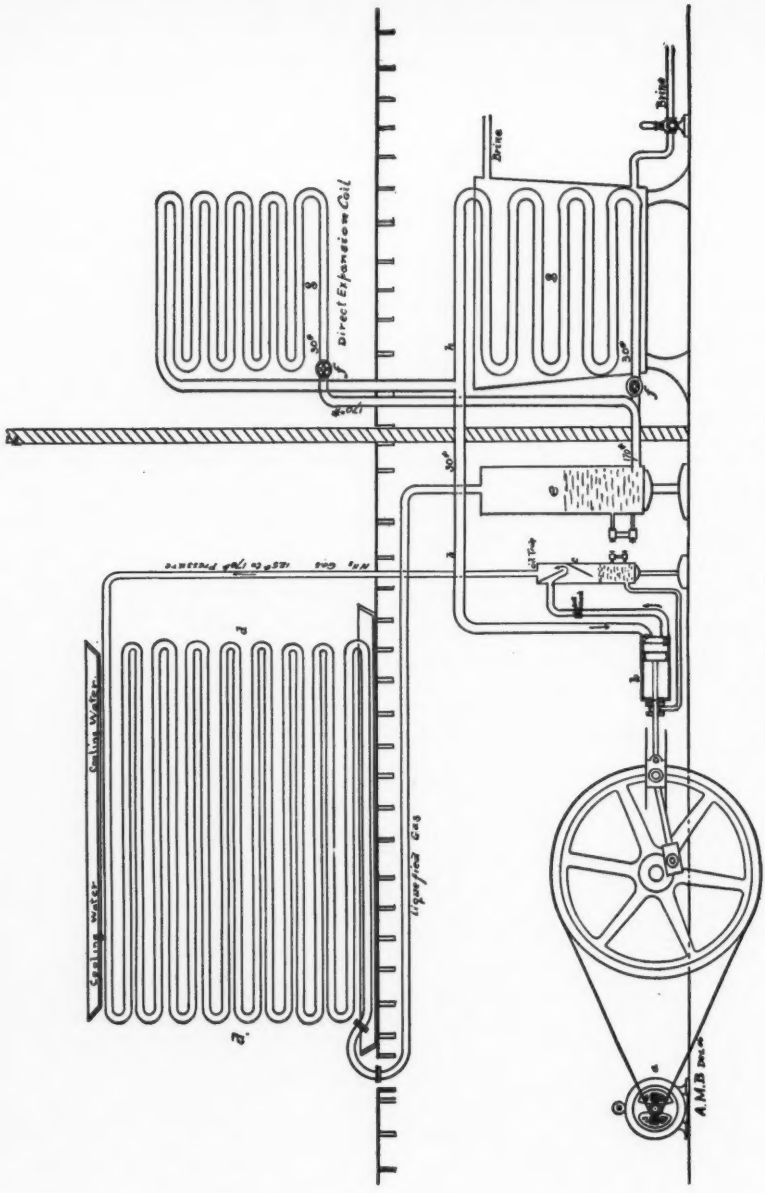


Diagram No. 1. Compression System.

B. Compressor or pump of suitable size and design and connected with the motive power directly by belt or otherwise.

C. Oil trap and separator.

D. Condenser or gas apparatus.

E. Liquid ammonia receiver.

F. Expansion valve.

G. Expansion coils, brine tank, cooling rooms, etc.

H. Suction pipe from expansion coils.

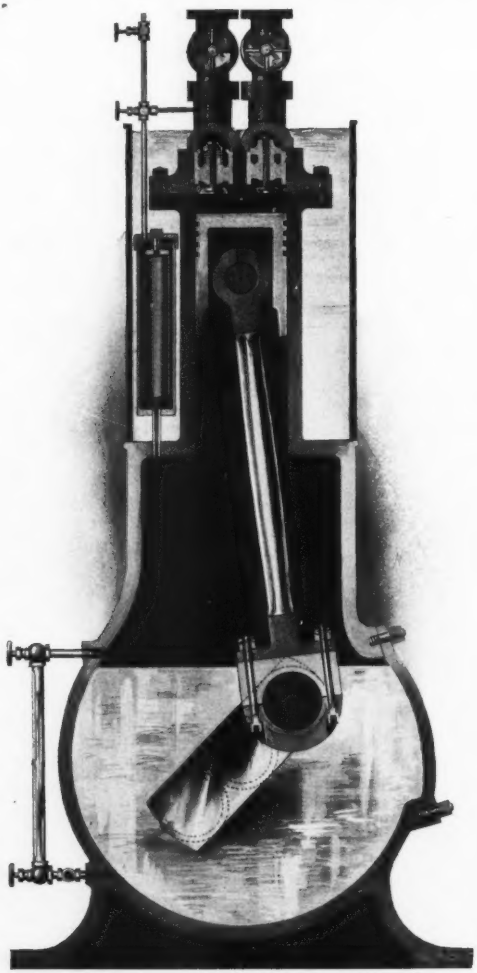
Cycle of Operation. The cycle of operation is one that is continuous, the gas from the coils in the refrigerating rooms is drawn into the compressor and discharged at a higher pressure, from 125 to 170 pounds, depending on the temperature of the cooling water at the condenser, where, owing to the pressure and lowered temperature, the gas is liquefied, thereby being reduced in volume, making room for more gas without an increase in pressure. The liquefied gas is led to the receiver and from there distributed to the various places where refrigeration is wanted. At these places the flow of liquid is regulated by an expansion valve, and as the liquid gas, still at the condenser pressure of 125 to 170 pounds, passes into an expansion coil where the pressure is much lower, usually from 0 to 30 pounds, it passes off or expands into a gaseous state. This change requires heat, which is absorbed from the outer surface of these expansion coils, thus cooling the rooms, brine tank or other places where these coils are placed. After the gas has fulfilled its mission, it passes on through the return or suction pipe back to the compressor, and the cycle is repeated.

Apparatus. The motive power used to drive the compressor varies with conditions, the larger installations, fifty to five hundred ton machines, using slow speed steam engines, while in smaller plants the compressors are driven by steam, gas, gasolene or producer gas engines, or electric motors, direct connected, geared or belted, or driven from a main line shaft. It requires from 1.5 to 3 H. P. per ton of refrigeration capacity, depending on the size of the machine, the larger units having the higher efficiency.

Compressor. Like any air pump the compressor consists of a cylinder and piston with suitable inlet and outlet valves, stuffing box, crossheads, etc., mounted on a suitable bed, similar in many respects to a steam engine. They are of various forms and types, each manufacturer having some distinct peculiarity. The single acting machine compresses the gas only at one end of the cylinder, while in the double acting machine valves are placed at both ends. Some compressors are water-jacketed to remove the heat of compression, these being known as dry gas machines; others not so provided, called wet or humid gas machines, being kept cool by the humid or partially liquid gas returning to the machine, and in one type the cylinders are cooled by the injection of oil into the cylinder at every stroke of the piston.

Oil Trap and Separator. As its name implies, this device is intended to catch the oil as it comes with the gas from the compressor, for even in

the dry gas and wet gas machines the small amount of oil required for lubricating the piston rod is carried over with the ammonia gas, and if not checked would be distributed throughout the system, reducing the efficiency of the system by forming an insulating coating or film on the



Sectional end view of a small single acting Ammonia Compressor, showing the suction and discharge valves.
Note jacketed cylinder and splash system of lubrication in crank case.

inside of the piping. It consists of an iron or steel cylinder, into the side of which, near the bottom, the gas from the compressor passes, impinging upon the opposite wall and baffle plates, depositing the oil and allowing the gas to pass out through the top. This is known as the high pressure trap, and from the bottom there is a pipe conducting oil to the stuffing box, thus acting as an automatic lubricator. Sometimes an auxiliary trap, known as the low pressure trap, is installed for drawing off the oil without losing any ammonia. The oil traps are provided with gauge glasses with *automatic checks* that will close them up in case the glass breaks.

Condenser. This may be one of four types, in all of which flowing water is utilized to cool the compressed gas to a point of liquefaction; the cooler the water, the lower the pressure required. The atmospheric condenser is probably the most widely used type and most familiar, so conspicuous with its slatted frame enclosure rising above the highest roof of the plant. It consists of vertical coils of pipe arranged horizontally one above the other, over which water flows from a trough at the top, thus cooling the compressed ammonia or other gas which flows through these pipes. In installations where the liquid ammonia receiver is not of such size as to hold the entire charge, the liquefied gas remains in the lower coils of the condenser until used.

The submerged condenser is similar to the above except that a number of these vertical coils are placed side by side and submerged in a large tank of water, kept cold by the overflow of hot water at the top, and is usually located in or near the engine room.

The Double Tube Condenser is coming into general use and is rapidly supplanting the atmospheric condenser. It consists of a series of coils one pipe within another, arranged so that the ammonia is circulated downward through the outer and larger pipes, while the cooling water is

Double Tube Condenser. (The double tube brine cooler is almost identical.)

circulated in the opposite direction through the inner and smaller pipes. This type may be located anywhere except where temperature is abnormally high or so low as to be subject to freezing.

Another form of condenser quite different from the above, and usually found in absorption systems, consists of a cast-iron or semi-steel cylinder

Liquid Ammonia Receiver.

containing several sets of pipe coils, through which cold water flows, the ammonia gas in the cylinder being cooled by contact with these pipes. This type quite frequently is used as a liquid ammonia receiver as well and is provided with suitable gauge glasses with the usual cut-off cocks which close automatically in case a gauge glass breaks.

Liquid Ammonia Receiver. This is usually located in the engine room and consists of a cast-iron or steel cylinder, provided with gauge glass and automatic cocks, and also a small oil well at the bottom. The size varies not so much with the capacity of the plant as with the ideas of the engineer or designer. Some are large enough to hold the entire charge of liquid refrigerating medium, while others will take care of all except that in the expansion side; others again being so small that the lower coils of the condenser serve at times as a liquid receiver. In some installations an auxiliary receiver is provided and located either near the main receiver or immediately below the condenser. This permits the cleaning out or making of changes in either one without shutting down the whole system.

Expansion Valve. This is, as its name implies, the valve which permits the liquid ammonia to pass into a space or coil at a lower pressure, where the liquid expands into a gas. This valve, like all other ammonia fittings and valves, is made of iron or steel and is a needle valve, permitting a fine adjustment.

This completes that portion of the plant which produces the refrigerating medium; *i. e.*, a liquefied gas, ready to be sent to the coolers to accomplish its refrigerating mission of absorbing heat in its change from a liquid to a gas.

ABSORPTION SYSTEM.

(See Diagram No. 2.)

A. Steam heated generator, containing aqua ammonia.

B. Analyzer, where ascending ammonia gas is enriched by the incoming strong liquor.

C. Rectifier, where water vapor is separated from ammonia by distillations.

D. Condenser and liquid ammonia receiver.

E. Expansion valve.

F. Brine cooler, or direct expansion coil.

G. Absorber.

H. Strong liquor pump.

I. Exchanger in which outgoing weak liquor heats the incoming strong liquor.

Cycle of Operation. As in the compression system the cycle of operation is a continuous one, but requires no heavy oscillating machinery. It is based on the great affinity that water has for ammonia; water at 57° F. absorbing 803 times its volume of gas. The ammonia gas after expansion is absorbed by the cooled spray of weak liquor in the absorber, thus enriching it and making it what is designated as strong liquor. This strong liquor is pumped to the exchanger, where it is heated by the hot, weak liquor, and leaving the exchanger passes down the analyzer where, owing to its increased temperature, some of its gas is given off. This ascends with the gas that comes up from the steam heated generator or

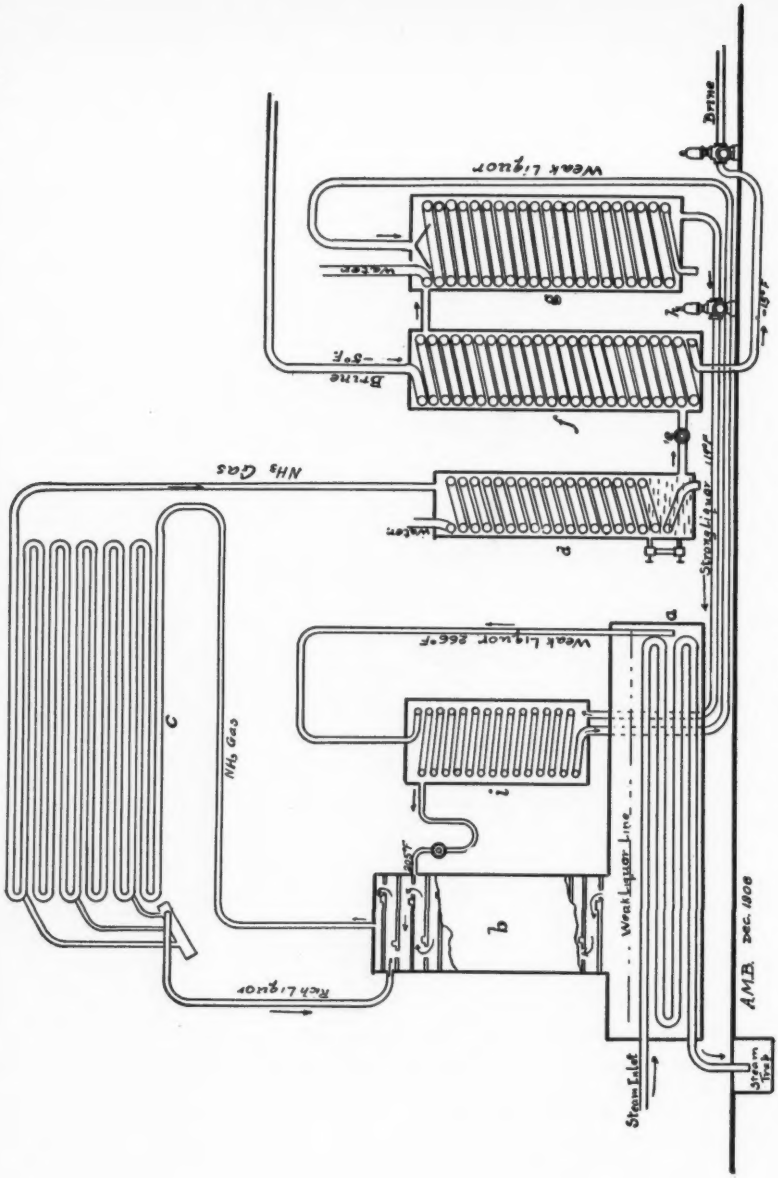


Diagram No. 2. Absorption System.

still. This practically drives off all the free gas and the liquor, by this time being weak, is forced through a coil in the exchanger to heat the incoming strong liquor and then goes on to the absorber. The ammonia gas, ascending from the generator via the analyzer, passes to the water cooled rectifier, where the entrained water is condensed and returned to the generator without liquefying the gas. From the rectifier the ammonia, practically free from water, passes to the water cooled condenser which serves as a liquid receiver. This makes up the liquefying part of the plant, refrigeration being accomplished in the same way as with the compression system.

Apparatus. The absorption system is used in this locality (Chicago), and has recently been installed in smaller units in many of our office buildings, hotels and department stores. These, except in the larger installations, utilize exhaust steam in the generator or still. Owing to the absence of heavy oscillating engines, compressors or other moving machinery, the apparatus of this system may be placed in the top stories of buildings, in contrast to the usual basement location of other systems. In one of our large cold storage houses the boilers and absorption machines for two hundred tons capacity are located on the ninth story, this part of the building being of fireproof construction, the only moving parts being the electrically driven pumps for strong liquor and brine. In this case four 75 K. W. direct connected dynamos, which furnish light and power for the entire plant, are also located on the same floor with the refrigerating system.

Following is the description of apparatus of a one hundred ton installation, the smaller capacity machines being similar, with modifications to suit conditions:—

Generator. The generator or still (in which ammonia gas is driven off from its liquor by means of heat) consists of a horizontal cast-iron shell about four feet in diameter and twelve feet long, provided with steam coils for heating the contained ammonia liquor. Mounted directly above, rising vertically and forming part of the generator, is the analyzer.

Analyzer. This part of the generator is a cast-iron shell three feet in diameter and twelve feet high, containing numerous trays over which the rich liquor passes, trickling downward from one to the other until it reaches the liquor in the generator. While the ammonia vapor from the still is passing up through the analyzer it is constantly being enriched by the ammonia from the rich liquor, the latter being increased in temperature in its downward passage. The pressure due to the escaping ammonia is regulated by the temperature of condensing water, and seldom exceeds one hundred and fifty pounds gauge pressure. A *safety valve* should be installed on analyzer with discharge to the outside of building.

Rectifier. This is similar to the condenser of a compression system, and is located on the roof, or in smaller systems submerged in a tank with flowing water located at or near the other apparatus. The object of the rectifier is not to cool the gas to a point of liquefaction, but as in

fractional distillation to remove one portion of it,—the water vapor that is carried up with the gas. Thus under normal operating conditions the water is condensed in the rectifier and returned to the generator, permitting the gas to leave as a practically anhydrous gas.

Condenser. The condenser in principle is the same as used in the compression system, but in construction is quite different, it being a cylinder that is also used as a liquid receiver. It consists of a heavy cast-iron shell three feet in diameter and ten feet high, with interior spiral coils through which the cooling water flows. The ammonia gas from the rectifier enters the shell at the top, and owing to the pressure and lowered temperature it is liquefied, the lower part of the shell being provided with gauge glasses with automatic cut-off cocks, thus serving as a liquid receiver.

Expansion Valve. This, as in the other system, regulates the flow of liquid gas into the refrigerating coils, which in this system usually consists of a special form of brine cooler, in which the ammonia expands in a large shell, the brine being circulated through coils contained therein. The expanded gas is led to the absorber, where it is taken up by weak liquor.

Absorber. The absorber consists of a steel shell about six feet in diameter and ten feet high, containing numerous coilsp. of pe through which cooling water flows. The ammonia gas from the cooler enters this shell near the top, and as it comes in contact with the weak liquor spray, which also enters at the top, it is absorbed, converting the weak into strong liquor. In absorbing the gas, work is done and the heat produced must be carried away by the cooling water, for the colder the absorbing liquor the more gas it will absorb.

Exchanger or Economizer. This auxiliary is mounted usually directly above and resting on the generator. It consists of a cast-iron shell about two feet six inches in diameter, ten feet high with iron pipe coils on the inside. As the weak liquor from the generator is made to pass through the exchanger in one direction, the strong liquor is made to pass in the other, thereby the heat from the weak liquor is given up to the comparatively cool, strong liquor. The latter thus more readily parts with its gas in the analyzer, and the cooler weak liquor is in better condition for the absorption of fresh gas in the absorber.

Strong Liquor Pump. This may be one of many types of pumps, and may be electrically driven or operated by steam or belted to a line shaft, though the electric or steam pumps are most commonly used.

Utilization of Liquefied Gas for Refrigeration. Having described the apparatus and methods for obtaining the liquefied gas, we now come to the utilization of this gas where the refrigeration is accomplished irrespective of the method used in obtaining the liquefied gas. Before this liquid can again be changed into a gas heat must be supplied, the amount corresponding to that which was given out in the act of liquefaction which was absorbed by the cooling water of the condenser.

The usual method is to let the liquid ammonia pass into a series of iron pipe coils, supported at the side walls or hung from the ceiling of well insulated rooms containing the goods that are to be cooled or kept cool. This is the Direct Expansion System. As the liquid passes through the expansion valve from a higher to a space with lower pressure it boils or evaporates, absorbing heat from and through the walls of the pipes, forming the coils, thereby cooling the air immediately surrounding the coils, as manifested by the snow-like condensation on the pipes. It is a well-known fact that the warmer the air the more moisture it will hold in suspension, while as it gets colder the moisture condenses and forms a snow-like coating on the refrigerating pipes, similar to the frost formation on the inside of window panes in very cold weather. The liquid is allowed to flow at such a rate as to absorb as much heat as the piping will transmit. Thus the liquid gas is not carried along to the compressor or absorber without expanding into the gaseous state, except as provided for in the humid or wet gas compressors, which having no water-jacketed cylinders must be kept reasonably cool by allowing a very small amount of the liquid gas, or saturated gas, to enter the cylinder along with the dry gas on the suction side. As the air in the room where expansion coils are located becomes colder and heavier the natural circulation allows it to absorb heat from the goods stored in the room, which heat is in turn conveyed to the expansion coils to effect further evaporation of the liquefied gas. Thus as the room becomes colder the rate at which the heat is supplied becomes diminished and, consequently, not so much of the liquid gas is required; in fact, to maintain a given temperature enough only is needed to supply that refrigeration which is lost through the imperfect insulation and the opening of doors or introduction of warm goods.

All installations for utilizing the liquid gas in refrigeration are based upon the above principle, though there are modifications of this and the indirect systems used to suit certain requirements. If the expansion coils, instead of being placed in a room, are placed in a large tank containing a brine made of calcium chloride—or ordinary salt, or if in place of a brine tank the more modern type of double pipe brine cooler is used, the same process goes on. This is the *Brine System*, the heat for vaporizing the liquid gas being supplied by the brine, which is circulated by means of pumps through coils in the cooling rooms. It requires about double the amount of piping for this as for the direct expansion system. In the sheet system, as used in some of the modern packing houses, especially in hanging floors for beef, the cold brine is pumped to a series of troughs from which sheets of cloth are suspended down which the brine is allowed to flow, thus offering a large surface for cooling the circulating air. These sheet systems are located on a mezzanine floor about six feet high, with openings in the floor to allow the free circulation of cold air to the hanging floor below. A large pan takes care of the brine after leaving the sheets, it being returned to the cooling tank.

Another indirect system is one in which the expansion coils in groups are placed in front of a large blower fan, and by means of wooden ducts (sometimes metal or plaster lined) the cooled air is conducted to the rooms or floors where the refrigeration is wanted. Most of the cooling rooms depend on natural circulation of the air, the cold air going to the bottom and the warmer air to the top of the room. Where absorption systems are used lower temperatures are usually maintained, and it is not unusual for them to circulate brine from ten to twenty degrees below zero; whereas, with compression systems direct expansion would more likely be used. Thus for special freezing operations, like the freezing of fish, the expansion coils or the brine coils of absorption systems are placed horizontally, shelve-like, in tiers, the pans of fish to be frozen being placed on these coils until frozen, which usually takes from ten to twelve hours.

In ice-making plants the expansion coils are placed in a large tank filled with brine, the ice cans being immersed between the various vertical rows of coils and means provided to keep the brine in circulation. In plants where plate ice is manufactured the expansion coils provided with flat steel plate sides are immersed vertically in the water to be frozen, the ice forming in large flat plates, each weighing several tons. Where can ice is manufactured, in order to produce crystal ice distilled water must be used, free from air, and hence additional apparatus is required, such as condensers, skimmers, reboilers and filters, all of which are only incidental and form no part of the refrigerating end of the plant.

This, in a general way, outlines the methods used for obtaining refrigeration from the products of the gas-liquefying part of the plant, irrespective of whether the compression or absorption system is used.

CARBON DIOXIDE SYSTEM.

Carbon dioxide systems in principle are identical with the compression system as outlined above. For a given capacity, however, the compressor required is smaller than that in any other system, the cylinder being one-seventh the size (in volume) of that required for ammonia. This advantage of small cylinder bore, small piston and valves, makes this system practicable, for the working pressure is about 1,000 pounds per square inch; the gauges reading in atmospheres, thus 65 on the gauge corresponding to about 975 pounds per square inch. The critical temperature above which the gas cannot be liquefied is about 89° F., and therefore the system is only practicable where cooling water for condensers considerably below this temperature is available the year round. A valuable adjunct in this system, where such high pressures are maintained (1,000 pounds on the compression and 300 pounds on the suction side), is a safety valve, made possible on account of the non-poisonous nature of the gas up to 8 per cent in air. The liquid carbon dioxide is readily obtained, being extensively used in the manufacture of soda water and other aerated waters, also in saloons for maintaining pressure upon the beer. It comes in heavy steel drums or bottles 6 to 10 inches in

diameter and 4 to 7 feet long, which manufacturers claim will withstand 3,500 pounds pressure. A safety blow-out plug or vent is provided, which would blow out should the pressure rise to 1,800 pounds, the pressure normally in the tank being about 1,200 pounds per square inch.

Carbon dioxide (CO_2) is obtained from the fermenting vats of large breweries, or (as more commonly produced) by the complete combustion of coke. It is purified with certain chemical solutions which have the property of absorbing when cold and yielding when heated the gas in a very pure state, absorbing or liberating the impurities. The carbon dioxide machines are coming into favor in this locality for the smaller installations, up to 50 ton refrigerating capacity, mostly on account of the non-poisonous and practically odorless nature of the gas, its installation in hotels, department stores, restaurants, markets and large apartment buildings being chosen to avoid the excitement and inconvenience to patrons that might be caused by an ammonia leak were such system installed.

HAZARDS.

The hazards of an ammonia system that may be attributed to the refrigerating media are few and not very serious. Other hazards that may be present are those due to physical conditions under which they are found, and not to the use of ammonia, as will be shown later on.

Let us bear in mind the physical properties of ammonia, which may be summarized in the following paragraph: —

Ammonia (NH_3) consists of one volume of nitrogen and three volumes of hydrogen, and is the only compound of these two elements known to exist. When pure it is colorless, an irrespirable gas, having a pungent odor and a burning or caustic taste. It is lighter than air and a gas at ordinary temperature. Under atmospheric pressure it liquefies at 28.6° below zero F., and solidifies or freezes into a transparent crystalline mass at 115° below zero F., in which state it is almost odorless and is heavier than its liquid. It can be liquefied at higher temperatures (up to 266° F.) by increasing the pressure, so that at 86° F. it requires 170 lbs. pressure for liquefaction. Anhydrous ammonia is the name for that used in compression systems and, as its name implies, contains no water. Ammonia gas is poisonous (irrespirable) and an atmosphere containing one-half of one per cent is considered dangerous.

Manufacture. Anhydrous ammonia is manufactured by a purifying process from the ammonia liquor obtained from gas and coke plants where it forms one of the by-products of the plant. Even that which is manufactured by one of the large packers of Chicago is made in this way and not, as is commonly supposed, from waste products of the packing house. Manufacture of anhydrous ammonia has reached the highest degree of perfection. Less than twenty years ago ammonia with 2½ per cent of impurities was considered amply pure for refrigerating purposes; whereas, at the present time, the impurities to be found are nothing more than traces that almost

defy detection, and a drum of anhydrous gas that would show one-hundredth of one per cent of impurities would be discarded. Each drum as filled is weighed and tested. The liquid gas is put into steel drums which are tested to 1,000 lbs., and are about 10 inches in diameter and 4 feet long for the 50 lb. size, and 7 feet long for the 100 lb. size, one manufacturer putting out a drum of 150 lbs. capacity. These drums are not completely filled, space of about 20 per cent of the volume being left for the expansion of the gas due to change of temperature.

Disassociation. At 900° F. ammonia disassociates, nitrogen and hydrogen being set free. It is probable that such change may take place to a very limited extent at lower temperatures between 212° and 900° F., but not to the extent so frequently supposed.

Inflammability. Ammonia is not combustible, and a flame is extinguished if plunged into the gas. In a liquid form it will extinguish a flame in the same manner as if water were used. If a flame of sufficient heat is applied to a jet of ammonia, the hydrogen due to decomposition in presence of oxygen burns as long as the flame supplies the heat for decomposition, and as long as an atmosphere of oxygen is present to support combustion. The writer has verified most of these assertions, making his experiments with the liquefied gas as taken from several drums at the factory. A blow torch held across the stream of escaping gas from a drum was almost blown out, and when gas escaped with less force it blew a hole through the flame. In this, as also when a torch was applied to the outer edges of the stream of escaping gas, it was with an interrupted weak and flickering flame that the disassociated gas would burn.

Explosiveness. Ammonia in air or mixed with air is not explosive. If mixed with pure oxygen it may be ignited and burns with a pale yellow flame, and as claimed by some authorities, if mixed in proportions of four volumes of ammonia and three volumes of oxygen it becomes explosive if ignited by a spark or flame. Ammonia in combination with chlorine or iodine forms explosive compounds, but have no bearing on the subject of refrigeration. Like any other gas, if confined in steel drums and the temperature is raised sufficiently, the pressure of the expanding gas will rupture the drum.

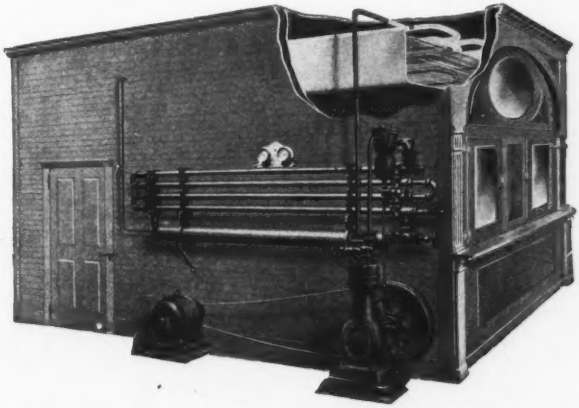
Solubility. Ammonia is remarkably soluble in water, so much so that one volume of water at 32° F., will absorb 1148 volumes of gas, and at 57° F. 803 volumes of gas. As already stated, this property makes possible the absorption system. The solution of the gas in water was formerly known as hartshorn, but now sold in varying strength from 10 to 26% and called aqua ammonia.

Corrosion. Ammonia does not attack iron or steel, but rapidly attacks and corrodes copper, brass, nickel, or any of their alloys. For this reason, in all ammonia systems piping and fittings are made of iron, steel or semi-steel, lead gaskets being used at the unions.

Pressures. In the ammonia compression system the pressure from the compressor to the expansion valve ranges from 125 to 170 lbs. under normal working conditions, though in warmer climates it reaches 220 to

250 lbs. From the expansion valve back to the suction valve of the compressor the pressure seldom exceeds 30 lbs. We will, therefore, start at the compresser where the pressure is created and follow the hazards as they occur in the cycle of operation.

Hazards. The compressor is usually driven by a steam engine, which necessitates a steam boiler plant, the hazards of which are well known and not ditterent from those of any other steam plant. This also applies to any other motive power that might be used, be it electrical, gas or water power; *i. e.*, that the motive power hazard is not altered because of the fact that it is used to operate a refrigerating system. The compressor cylinder is lubri-



Complete one ton ammonia refrigeration plant, showing liquid receiver at bottom of double tube condenser and expansion coils in a brine tank located inside of the refrigerator.

cated by sight feed lubricators, little lubrication being required, especially in wet gas machines, where they depend only on the small amount of oil introduced by the piston rod. One system referred to later used injected oil in the cylinder for other than lubricating purposes. The lubricating oil used is a paraffin oil of light color, one that will not saponify, will not congeal above 0° F., and has a flash point above 360° F. This lubricating oil, in small quantities, is carried over with the hot gas to the oil trap nearby, where the oil is separated from the gas, falling to the lower part of the trap.

This oil has always been and is still a hazard of some importance, since the presence of an open flame or glowing filament of a broken incandescent electric light may ignite the vaporized oil, which would result from an accident to the apparatus, such as a cylinder head being knocked out or a valve broken off close to the compressor. In past years such accidents resulted in fires more frequently than at the present time, due to the impurities, consisting mostly of ethers contained in the ammonia gases. However,

the prohibition of open lights near the compressor or oil trap is not a severe one, especially in these days when the incandescent electric lights provided with vaporproof globes are so universally used in and about engine rooms. The gauge glasses on the oil trap and ammonia receivers are all provided with automatic ball stops that shut off the gas if gauge glass should break. The oil trap in some instances has an auxiliary attachment, called an oil separator, connected with the suction side of the machines to facilitate withdrawal of oil from trap without loss of ammonia.

Quite recently manufacturers are seeing the importance of providing an automatic valve check in the exhaust as well as in the suction pipe of the compressor, which prevents the entire charge of ammonia gas escaping should something go wrong with the compressor. There are some patented devices on the market, electrical or mechanical, which operate these check valves and at the same time stop the engine or shut off the power automatically should an accident occur at the compressor or in any part of the piping. These should be required in all installations, thus automatically shutting off all the ammonia in condenser and liquid receiver, as well as in the expansion coils and return lines. There is practically no hazard from the oil trap to condenser and back to the liquid receiver. At the condenser a small cock is provided for drawing off air or other inert gas that might be in the system but forms no hazard. There are traces of oil that get past the oil trap, which in some installations are taken up by an auxiliary oil trap at the condenser, in others at the liquid receiver. An engineer who is ignorant or careless might let his trap get too full, in which case the oil would pass to the liquid receiver, and even go beyond to the expansion valve, where it would settle in the well at the bottom of the riser. Beyond the expansion valve the pressure seldom exceeds 30 lbs., and in freezer rooms runs as low as one pound or even less. In this part of the system the hazards are nil, for a break in this part of the system, even with an open flame near at hand, would not cause an explosion or fire; if anything, the gas would extinguish the flame, depriving it of oxygen. Of course, the presence of ammonia might retard the action of the firemen, but not very long, since the water thown on the fire would soon absorb the gases, carrying them away.

The hazard of a gas in a confined space at high pressure, without a safety valve, is one present at the tanks in which the anhydrous ammonia is delivered. And yet, at ordinary temperatures there is but little danger. If fire occurred near one of these drums the pressure would increase to a point where drum would rupture, causing an explosion. These drums, where supply must be kept on hand, should be stored in one of the cooling rooms, and not left in a warm engine or boiler room, or even exposed to the hot sun in tropical climates. The hazards of an explosion due to liquefied gas in the ammonia receiver is not very great, owing to the open system back to condenser, and in other directions to expansion coils. In case of fire near the receiver, the liquid would vaporize and go to a cooler portion of the system, except in a general fire where the temperature would increase

the pressure and cause rupture at the weakest point in the system. Another condition under which a considerable increase in pressure might cause a rupture in the system would be where, through some accident or error, the condenser water were shut off. The pressure would then increase as the temperature rises, due to heat of compression, a condition the writer has never heard or read of where the engineer did not discover such derangement before any serious accident occurred. Of course one might provide a safety valve with vent to the outside to meet such contingencies, and in fact quite recently such safety valves are being installed. The City Boiler Inspection Department of the City of Chicago inspects all refrigerating plants regularly and requires the following safeguards :—

(*a*) **Check valves** on discharge lines and suction lines and recommend an automatic engine stop.

(*b*) **Safety valves** on ammonia machines set to go off at 250 pounds, the size of safety or pop valve to be one-half the diameter, *i. e.*, one-fourth of the area of discharge or high pressure line. Safety valves to discharge outside of building or into the suction side of the system. Pop valves to be located between the compressor and shut-off valve of the discharge line, or on the compressor itself.

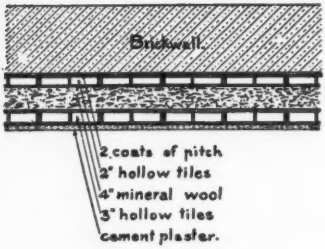
On absorption machines to be located on the analyzer head with the discharge outside or into the absorber.

In carbonic gas compressors, pop valve is set to operate at 1,400 pounds pressure and may discharge into the room.

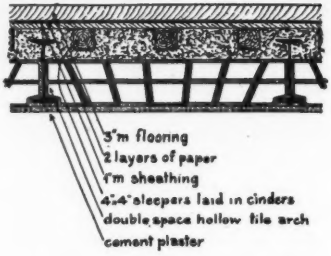
In the absorption system the hazards are even fewer than in the compression system. Steam is used in the generator, exhaust steam being used in the smaller installations, forming the ordinary steam-pipe hazard. There is no oil in the system, and the one condition under which decomposition of ammonia might take place would be if the strong liquor were not supplied fast enough to the generator, allowing the gas above the liquor in the generator to come in contact with the steam pipes. This is provided for by the installation of an automatic float valve which controls the height of liquor in the generator. If some of the gas were disassociated into the hydrogen and nitrogen, it would be retained in the system and it would not be long before the engineer would discover it. As mentioned above, safety valves should be installed on the analyzer head.

The hazards of the carbon dioxide systems are somewhat lessened by the fact that the gas is not inflammable or explosive and a good extinguisher of fire when confined at the fire. Nevertheless, the excessive pressures might cause explosions, which indirectly might be the cause of the fire, such as the breaking of gas pipes, electric wires, etc. In this system the lubricating oil hazard, if anything, is increased, owing to the greater quantity of oil used and the extremely high pressure at which the system is operated.

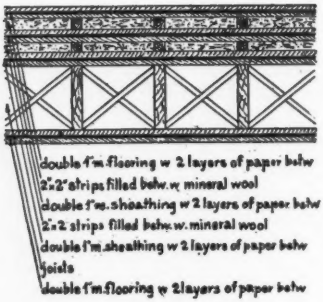
As to the hazards in the various systems of utilizing refrigeration, whether by direct expansion brine, indirect air blast or suction, sheet or other systems, the hazards are not any more serious than the same conditions



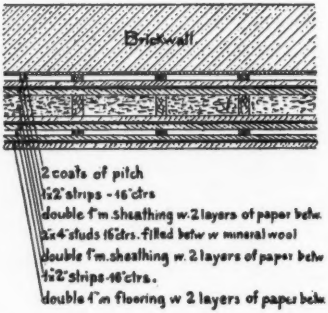
Insulation of walls for fireproof buildings.



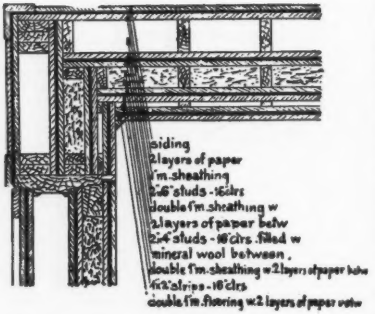
Insulation of ceilings for fireproof buildings


double 1"m.flooring w 2 layers of paper betw
2"x2" strips filled betw.w. mineral wool
double 1"m. sheathing w 2 layers of paper betw
2"x2 strips filled betw.w.mineral wool
double 1"m.sheathing w 2 layers of paper betw
joists
double 1"m.flooring w 2layers of paper betw

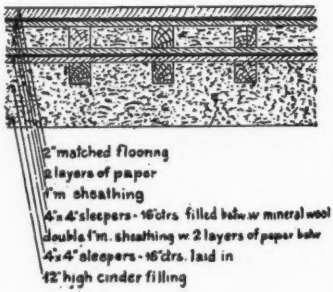
Insulation of ceilings for wood construction.


Brickwall
2 coats of pitch
1"x2" strips - 16" ctrs
double 1"m.sheathing w 2 layers of paper betw.
2"x4" studs 16" ctrs. filled betw w mineral wool
double 1"m.sheathing w 2 layers of paper betw
1"x2" strips 16" ctrs.
double 1"m flooring w 2 layers of paper betw

Wooden insulation for brickwall.


siding
2 layers of paper
1"m.sheathing
2"x6" studs - 16" ctrs
double 1"m.sheathing w
2 layers of paper betw
2"x4" studs - 16" ctrs. filled w
mineral wool between.
double 1"m.sheathing w 2 layers of paper betw
1"x2" strips - 16" ctrs
double 1"m.flooring w 2 layers of paper betw

Insulation of walls built of wood.


2" matched flooring
2 layers of paper
1"m sheathing
4"x 4" sleepers - 16" ctrs. filled betw.w mineral wool
double 1"m. sheathing w 2 layers of paper betw
4"x 4" sleepers - 16" ctrs. laid in
12" high cinder filling

Insulation of groundfloor.

and arrangements of apparatus would produce if used for other purposes; *i. e.*, a motor hazard would not be altered because the motor drives a fan that blows air over refrigerating coils or operates brine pump which circulates the cold brine through pipes in the cooling room.

A great deal might be said regarding the construction of the cooling rooms, owing to the numerous methods and materials used for insulating against the entrance of heat from the outside. This might well be treated under construction of warehouses, but for the present it may be said that in older installations the wood furring with double sheathing and building paper is used, air spaces in some instances being blocked off so as to prevent circulation of air. This is also accomplished by filling hollow spaces with insulating substances, having a great many voids, such as ground cork, wood shavings, mineral wool and charcoal. Pitch is sometimes used not only for coating the walls and building paper, but also as a filling, being put in so as to be from one to two inches thick. In the sheet system and cold blast system there are large floor openings for circulation of cold air, which are conducive to spread of fires.

Hollow brick walls, with wood shavings or sawdust filling, is probably the best method for insulating buildings, from fire hazard standpoint, except in fireproof construction or other construction where hollow tile is used; but as was demonstrated in the Schwarzschild & Sulsberger warehouse fire at Chicago, in February, 1905, it is important that there be **exterior** openings on all floors and sides, so that the fire department can get at the seat of the fire.

The method of lighting forms a hazard no different from that of other warehouses or buildings. Candles and lanterns will be found in cold storage warehouses unless the electric lights are well distributed and easily controlled. The electric wiring is liable to deteriorate very much faster in cold storage plants where direct expansion is used, owing to the corroding effect of the ammonia gas upon copper or brass, and owing to the fact that in certain classes of storage rooms the moisture condenses everywhere and especially on the wires, porcelain supports, etc. Even though the ammonia system is considered tight, there are always present traces of ammonia in the air, and it usually finds its way through the house.

Calcium chloride and lime are used for purifying and drying the air in certain rooms, especially where eggs are kept, the former being placed in shallow metal trays, and the lime when not in pans spread on the floor. These rooms are kept so that everything is dry and what moisture is present condenses as frost upon the pipes. Care should be taken of the lime, however, as to the manner of its storage and distribution.

In cold storage warehouses, as in other warehouses, rats are ever present and the hazard that they introduce is probably augmented by the fact that the low temperature makes them build warmer nests and makes them more diligent in their search for old rags, etc., and hence oily waste and other refuse should be strictly guarded and kept in proper receptacles.

Freezing Preventives for Water Pails and Chemical Extinguishers.

By J. Albert Robinson.

(Revised and reprinted from QUARTERLY, April, 1909.)

Fire protection engineers are frequently asked to recommend something that may be used in water pails and chemical extinguishers to prevent their contents from freezing. The following facts and tables concerning materials that will lower the freezing point of solutions may be of interest to such, and serve as suggestions, to be used according to the needs of the case in hand.

Common Salt.

Common salt has been much used to prevent freezing of water in pails, and so forth, but it does not lower the freezing point sufficiently to be of very great use in average cold weather. If the solution is too concentrated its disagreeable propensity to "creep" and crystallize all over the receptacle makes it extremely objectionable. It will always attack and rust metals with more or less rapidity.

Common salt, or sodium chloride, is the only salt that has been recommended for use in chemical extinguishers, and this only by a few manufacturers. They advise the use of one quart of salt for a three-gallon tank. This will lower the freezing point to about 15° F. above zero, but will not withstand a continuous cold spell in northern climates.

The following table gives the freezing points of salt solutions of different strengths.

FREEZING POINT OF SALT SOLUTIONS

Percentage of Salt to Water by Weight	Freezing Point
1 per cent salt	31.8 degrees F.
5 per cent salt	25.4 degrees F.
10 per cent salt	18.6 degrees F.
15 per cent salt	12.2 degrees F.
20 per cent salt	6.8 degrees F.
25 per cent salt	1.0 degrees F.

Use one pound of salt to 18 gallons of water. Add four ounces of salt to this solution for every degree Fahrenheit below 30. One gallon of water weighs 8.35 pounds.

Another table has been expressed as follows:—

COMMON SALT (Sodium Chloride)

Pounds per gallon	Freezing Point—Degrees Fahrenheit
½	24 above zero
1	18 " "
1¼	15 " "
1½	12 " "
1¾	9 " "
2	6 " "
2¼	3 " "
2½	1 " "
3	3 below zero
3½	8 " "

The solution should be mixed in a vat before being placed in barrels, care being exercised to see that the salt is entirely dissolved. If dumped into a barrel and covered with water, or if thrown into a barrel of water, the salt will be only partially dissolved and unsatisfactory results obtained. Barrels with wooden hoops should be used, as salt will corrode steel hoops or steel tanks.

Calcium Chloride.

This is a white, solid substance, like common salt, which makes a colorless solution when dissolved in water. Unlike salt it does not rust metal. It has, however, a tendency to attack solder. Because of this, and also the chemical reaction that would be involved, it is not suitable for use in chemical extinguishers. A small amount of lime added to the solution will remove any tendency to acidity. It has no odor and will remain odorless even if left standing for a long time. It will not evaporate nor form sediment. Calcium chloride is hygroscopic and will quite readily absorb moisture from the air. If water freezes, this salt will not "creep" and "grow" (crystallize) over the receptacle as does common salt.

The following facts should be taken into consideration:—

The amount of calcium chloride necessary to make a saturated solution decreases with the temperature of the solution. A solution which is saturated at sixty degrees will be super-saturated at zero, and the excess crystalizes out and floats on the surface of the water, forming a film which may collect dirt and filth. This feature is not so objectionable, however, as the crystallization of salt, which takes place under most conditions.

The Solvay Process Company's 75% fused or solid calcium chloride is sold in thin sheet iron drums of 610 pounds capacity, at $20 per ton. It is also put up in 375 pound drums at about 1½ cents per pound. It can be bought from any other dealer in heavy chemicals. If one is using much calcium chloride, it is preferable to regulate the strength by using a special hydrometer marked in "Degrees Salometer" as well as in "Degrees Beaumé."

The following table shows the temperature at which water will freeze with given quantities of calcium chloride in solution. It also gives the degrees Salometer and degrees Beaumé at 60° F.

Pounds per Gallon of Water	Temperature of Freezing	Degrees Salometer	Degrees Beaumé
½	+29 Fahr.	13	3
1	27 Fahr.	27	6
1¼	25 Fahr.	36	9
1½	23 Fahr.	40	10
1¾	21 Fahr.	44	11
2	18 Fahr.	52	13
2¼	14 Fahr.	62	15
2½	+3-4 Fahr.	80	20
3	—1-4 Fahr.	88	22
3½	—8-11 Fahr.	95	24
4	—17-19 Fahr.	104	26
4½	—27-29 Fahr.	112	28
5	—39-41 Fahr.	120	30
5½	—50-54 Fahr.	124	32

The following table gives the quantity of "Solvay" fused or solid calcium chloride required to make solutions of given specific gravities and corresponding freezing points as prepared by the manufacturers.

Specific Gravity	Per Cu. Ft. Solution	Per Gal. Solution	Freezing Point
1.250	28.06 lbs.	3.76 lbs.	—32.6°F.
1.225	25.06	3.36	—19.5
1.200	22.05	2.95	— 8.7
1.175	19.15	2.56	Zero
1.150	16.26	2.18	+ 7.5
1.125	13.47	1.80	+13.3
1.100	10.70	1.43	+18.5

It can also be furnished in 110-gallon drums of 1.400 specific gravity (containing 40 per cent of calcium chloride) which, when diluted with an equal quantity of water, will give 220 gallons of solution of sufficient strength to stand a temperature of 9° below zero Fahr. and to fill about 75 standard fire buckets, or four 52-gallon fire casks.

Where calcium chloride solution is used, wooden barrels should first be well coated inside with asphaltum or with a mixture of crude paraffin and resin to prevent shrinking of staves and consequent leakage.

Glycerine.

This is a colorless, viscid liquid, without odor, and miscible with water in all proportions. It has a specific gravity of approximately 1.25. Glycerine has no effect upon metals, but has a tendency to disintegrate rubber. It has been stated, however, that the continued use of glycerine in water renders it liable to a decomposition that would develop compounds having a corrosive action on metals. It might be advisable to test with litmus paper occasionally for acid reaction. It is probable that if this occurred in a chemical extinguisher the acid would be neutralized by the sodium bicarbonate, with the generation of a small amount of carbonic

acid gas. Owing to the difference in density, considerable pains needs to be used, when mixing the glycerine with water, to insure a perfect solution.

Glycerine is sold in metal drums of 1,300 to 1,400 pounds capacity, at about 17 to 19 cents per pound. In smaller quantities, put up in 50 pound cans to order, it sells for 18 to 20 cents per pound. It can be procured from drug and chemical dealers.

Glycerine is recommended for use in chemical extinguishers by some manufacturers. It is even suggested that extinguishers containing a glycerine solution will put out more fire than the ordinary charge. This is explained by the fact that little globules of carbonic acid gas are better carried to the seat of the fire, where they are released by the impact.

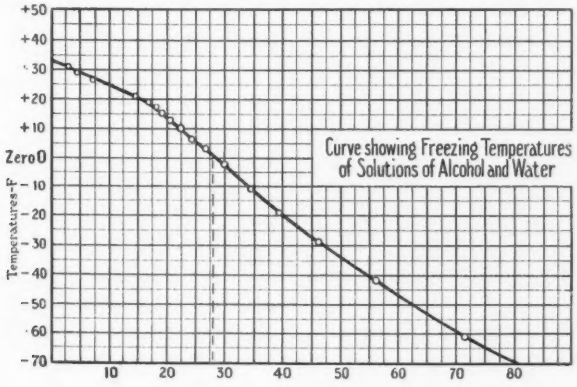
When using glycerine, it should be remembered that one gallon weighs 10½ pounds.

Pounds of Glycerine per Gallon Solution	Temperature Solution Will Withstand
3½	+10 degrees Fahr.
5¼	—10 degrees Fahr.
Quarts of Glycerine in a Standard Extinguisher	
3½	— 4 degrees Fahr.
4	—10 degrees Fahr.

Denatured Alcohol.

Denatured alcohol is too well known to need description. The disadvantages inherent in both calcium chloride and glycerine solutions are eliminated by the use of alcohol, in that it has no injurious action on either metal or rubber. Its use might introduce a serious hazard. A solution will become inflammable with about 50 per cent alcohol, and would vaporize at a greater dilution. However, it would rarely be necessary to have a solution of over 30 per cent alcohol. The use of alcohol has been suggested for the purpose of lowering the freezing point of the soda solution in chemical extinguishers; but this is impracticable, owing to the fact that the solubility of bi-carbonate of soda decreases very rapidly with the addition of alcohol.

The freezing point of different solutions is shown by the following curve :—



Illustrations.

20% Solution—(1 quart of denatured alcohol added to 1 gallon of water) freezes at about 10 degrees above zero.

30% Solution—(1½ quarts of denatured alcohol added to 1 gallon of water) freezes at about 5 degrees below zero.

40% Solution—(2½ quarts of denatured alcohol added to 1 gallon of water) freezes at about 20 degrees below zero.

50% Solution—(4 quarts of denatured alcohol added to 1 gallon of water) freezes at about 35 degrees below zero.

The exact condition of the solution and the temperature it will stand, can be determined by the use of such an instrument as the "Freezometer." By placing a small amount of the solution in the glass tube which accompanies the freezometer, the exact freezing point of the solution can at once be determined, regardless of the temperature of the solution itself. If more alcohol be required to fortify the solution so as to resist a lower temperature, it need only to be poured into the pails, etc., until the test with the freezometer shows the desired safety point. The freezometer is simple in form and construction. The price with test jar and wood case, complete, is $1.50.

A good grade of denatured alcohol is now being sold in the United States at forty-one to forty-two cents per gallon in barrel lots. In small quantities the price will average ten cents a gallon more.

Other Substances.

It is probable that the ordinary charge of sodium bicarbonate, as used in a standard chemical extinguisher, will depress the freezing point of the solution to about 25 or 20° F. above zero.

Substances such as ammonium nitrate and ammonium chloride (sal ammoniac), that have the property of lowering the freezing point of solutions, have been proposed, but because of the avidity with which they attack metals, are quite inadmissible.

It is said that solutions of borax, potassium oxide and sodium sulphate have a freezing point considerably below zero, but these substances have not been studied. Considerable study was given to the possible use of blue vitriol for chemical extinguishers by an expert, but he finally reported adversely.

Sulphuric Acid for Chemical Extinguishers.

Sulphuric acid is supposed to be able to withstand extreme cold, yet it is occasionally found frozen solid in the bottle within a chemical extinguisher while the soda solution remains unaffected. This seeming contradiction can be readily explained.

Sulphuric acid, in its commercial form known as oil of vitriol, has a specific gravity of 66° Beaumé. At this density it freezes at —29°. At 65.5° density it freezes at +13.4 and at 65° density it will freeze at +33.1° F. The appended table and diagram will show these changes more clearly and exhibit the peculiar characteristics of these changes.

Sulphuric acid is very hygroscopic, and, as may be seen from the table, a very slight dilution will send the freezing point above that of water. Sulphuric acid, once frozen, melts very slowly, and it is a far more serious matter to have this freeze than the water solution. Hence great care should be taken to see that the sulphuric acid is of the proper density. The ordinary loose porcelain or lead stoppers used on many approved extinguishers do not fit tightly enough to prevent some absorption. It is slower where the new deep cup stopper is used. A suggested remedy is to place a tablespoonful of kerosene oil into the bottle of acid. The oil floats on top and makes a seal. Also see that the bottle is set in the cradle properly and the cover of tank screwed on tightly.

The rate of absorption will vary so much according to local conditions that it is impossible to give the time necessary to render the freezing point of the acid above that of water. If an extinguisher is placed at a warm point, near a boiler room for instance, the air in the space around the bottle opening becomes more moist and the absorption will be more rapid. Where, however, the extinguisher is placed at a cool, dry point, the air is not so moist, and the absorption will be slower. For this reason, the absorption will ordinarily be slower in extinguishers which are exposed to cold weather.

It must be remembered that the retardation of chemical action between the acid and solution, that is likely to take place at low temperatures, cannot be overcome by any means suggested to overcome freezing. This must remain an adverse factor in the use of extinguishers in cold premises.

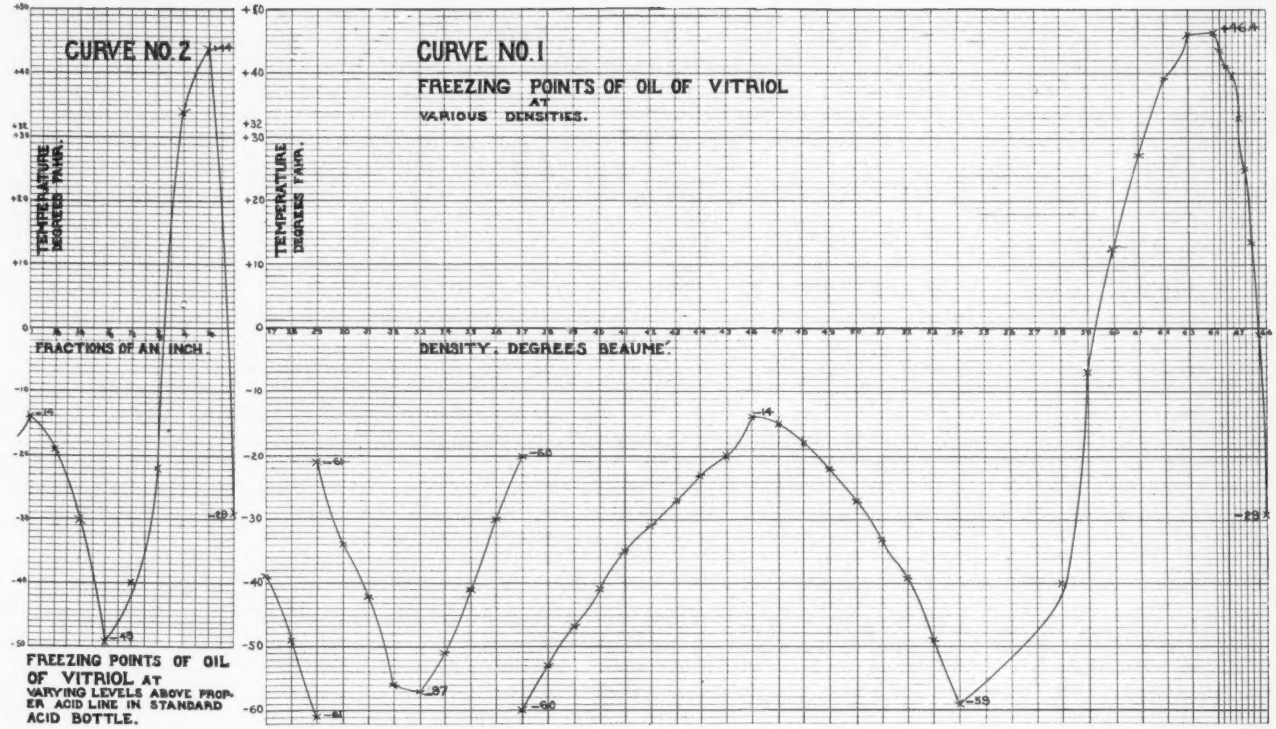
Table No. 1 shows the characteristics of commercial sulphuric acid known as oil of vitriol. This acid has a density of 66° Beaumé, and actually contains but 93.19 per cent of C. P. sulphuric acid, the remainder being water. But, as acid of this density is the ordinary commercial acid, it will contain 100 per cent oil of vitriol. We are only concerned with the results of adding water to this acid.

Table No. 2. As a guide in the field it may be convenient to estimate roughly the probable freezing point of acid in the bottle of a standard chemical extinguisher, according to the level of the acid above the proper level mark on the bottle, due to its absorption of water.

Assuming the original contents of a standard acid bottle to be oil of vitriol of 66° Beaumé and at the proper level, the addition of each one-eighth inch of water above that level will vary the densities and resultant freezing points approximately as given. It must be remembered, however, that this table can only be used as an approximation, for the acid may not have been of standard strength, and the bottle may not have been filled to proper level. Also, the size of bottle varies somewhat in different kinds of extinguishers.

Curve No. 1. Exhibits graphically the varying freezing points of oil of vitriol, according to densities.

Curve No. 2. Exhibits graphically the varying freezing points of the bottle of acid according to the height of acid above the proper level.


CURVE NO. 2
TEMPERATURE DEGREES FAHR.
FRACTIONS OF AN INCH.
CURVE NO. 1
FREEZING POINTS OF OIL OF VITRIOL AT VARIOUS DENSITIES.
TEMPERATURE DEGREES FAHR.
DENSITY. DEGREES BEAUME'.

FREEZING POINTS OF OIL OF VITRIOL AT VARYING LEVELS ABOVE PROPER ACID LINE IN STANDARD ACID BOTTLE.

Table No. 1

Degrees Beaumé	Freezing Point Degrees Fahr.	Per Cent Oil of Vitriol	Per Cent Water
66	—29	100.00	000.00
65¾	— 1	98.51	1.49
65½	+13.4	97.22	2.78
65¼	+24.6	96.10	3.90
65	+33.1	95.13	4.87
64¾	+39.9	94.23	5.77
64½	+41.1	93.40	6 60
64¼	+43.6	92.64	7.36
64	+46.4	91.92	8.08
63	+46.1	89.43	10.57
62	+39.1	87.24	12 76
61	+27.3	85.23	14.77
60	+12.6	83.35	16.65
59	— 7	81.54	18.46
58 (Below)	—40*	79.79	20.21
54	—59	73.11	26.89
50	—27	66.72	33.28
48	—18	63.65	36.35
47	—15	62.13	37.87
46	—14	60.60	39.40
45	—20	59.09	40.91
44	—23	57.58	42.42
40	—41	51.61	48.39
37	—60	47.20	52.80
36	—70	45.74	54.26
35	—81	44.28	55.72
34	—91	42.83	57.17
33	—97	41.40	58.60
32	—96	39.98	60.02
31	—82	38.55	61.45
30	—74	37.16	62.84
25	—23	30.34	69.66
24	—16	29.00	71.00
21	— 1.8	25.14	74.86
20	+ 1.6	23.87	76.13
15	+14.7	17.58	82.42
10	+22.8	11.56	88.44
5	+28.1	5.67	94.33
0	+32.0	0.00	100.00

Height of Liquid Above Acid Level	Approximate Density Degrees Beaumé	Approximate Freezing Points
1/16 inch	64¼	+44
¼ inch	61½	+34
3/8 inch	58½	—22
½ inch	55½	Below —40*
5/8 inch	53	—49
¾ inch	50½	—30
7/8 inch	48¼	—19
1 inch	46¼	—14

* Exact point indeterminate.

There appears to be no good reason why it is not practicable and really advisable to dilute the bottle of acid at once to about 59 degrees Beaumé, and thereby permanently prevent any danger of freezing from further absorption of water. Certain establishments, based on the information contained in this article, have already adopted this procedure, and are selling charges for chemical extinguishers prepared in this manner.

Automatic Sprinkler Systems.

Special attention has been drawn by the manufacturers to the desirability of using calcium chloride solution in automatic sprinkler systems where installed in warehouses and other places of extreme exposure during the winter months. They state that the use of calcium chloride does away with the necessity of maintaining a dry-pipe system with the extra cost of installation and the attending risk of disarrangement by leakage of water into the system through defective valves or through a failure of the air supply. For this purpose they recommend that the system be filled with calcium chloride solution of 1.225 or 1.250 specific gravity, and a check valve installed to separate this from the source of water supply.

Department of Fire Record

J. ALBERT ROBINSON, Superintendent.

The Carpet Yarn and Weave Mill Fire Record

The sprinkler record in carpet yarn and weave factories, as shown by our records, is most gratifying. Ninety per cent of the fires were extinguished with a small loss or no loss whatever. Over half of the fires were extinguished by the operation of three sprinklers or less. Ninety per cent were extinguished by the operation of less than twenty-five sprinklers and only five per cent of the fires were unsatisfactorily extinguished by the sprinklers. The sprinkler failures were due to the following causes: Unequipped portions, one case. Primary water supply deficient in pressure and quantity, two cases. Water shut off, two cases. Obstructions to distribution, one case.

It is interesting to note that inside protection equipment was used in about sixty per cent of the cases where a small or no loss resulted, and that outside protection equipment was used in eighty-six per cent where no loss resulted, and in fifty per cent of the cases where the loss was small.

The causes of fire are those which are to be expected in mills of this class. One interesting and important feature, however, is the frequency of fires in dyed yarn due apparently to spontaneous ignition. This suggests a fruitful field for research. Seventy per cent of the large loss fires were due to common hazard causes. About three-fourths of the fires occurred in the daytime, while the plant was in operation, and were first discovered by an employee. Eighty-nine per cent of the day fires were due to special hazard causes, while seventy-two per cent of the night fires were due to common causes. About half of the night fires were first discovered by a watchman, the remainder being nearly equally divided between sprinkler alarms and outsiders.

An intimate analysis of tables 14 to 19 inclusive shows several interesting facts. The nature of the primary supply had very little effect on the average number of sprinklers operating in each case. The number of fires extinguished or practically extinguished was also very little influenced by this factor, although the average waterworks pressure was about seventy pounds and the average gravity tank pressure was about twenty pounds.

The average number of heads which operated in all but the unsatisfactory cases was 6.6, and the average number in the cases where fire was entirely or practically extinguished was 3.9. Relatively where the fire was practically or entirely extinguished, the average number of sprinklers which operated increased with the decrease in pressure, being 3.5 sprinklers for a pressure of over fifty pounds and 7.8 sprinklers for pressure of less than fifteen pounds. In the cases where there was no claim for insurance indemnity the average was 3.5; where the loss was small, 6.5; and an average of over twenty-six sprinklers operated where the loss was large.

Only two fires reported occurred in factories equipped with dry-pipe systems. The operation of these was extremely satisfactory in each case.

There were only six fires, or five per cent, in which the secondary supply was a factor in the extinguishment.

Carpet Yarn and Weave Mills—Fire Record.

Total Number of Fires, 138.

I. CLASSIFICATION OF CAUSES.

Summary.

Common Causes.

	No. of Fires.	Per Cent of Common.	Per Cent of Whole.
Lighting	4	22.2	2.9
Heating	2	11.1	1.5
Power	3	16.6	2.2
Boiler	2	11.1	1.5
Workmen's Clothing	2	11.1	1.5
Matches	1	5.5	.7
Lightning	1	5.5	.7
Smoking by Watchman	1	5.5	.7
Rubbish	1	5.5	.7
Miscellaneous	1	5.5	.7
Total	18		13

Special Hazards Causes.

	No. of Fires.	Per Cent of Special.	Per Cent of Whole.
Picking	42	38.5	30.4
Carding	22	20.2	15.9
Drying	11	10.1	8.0
Stock	23	21.1	16.6
Raw 5			
Waste 5			
Yarn 13			
Dusting and Willowing	4	3.6	2.9
Weaving	4	3.6	2.9
Spinning	1	.9	.7
Garnetting	1	.9	.7
Finishing	1	.9	.7
Total	109		79
Exposure	1		.7
Unknown	10		7.2

Details.

Common Hazards.

Lighting 4

Gas inspector supposed to have ignited leaking gas at the meter while taking statement of the register.

Caused by employee carelessly allowing yarns he was carrying on his back to come in contact with gas jet, although gas jet had wire guard around it.

Grounded electric wire.

Swinging gas jet near loom, became loose and swung against harness.

Heating 2

Started in racks of finished goods, caused by burlap coming in contact with steam pipes.

Dirty broom in contact with steam pipes.

Power 3

Hot bearings under floor in picker house.

Friction clutch on machine became loose and did not properly interlock with starting mechanism of cutter when power was applied.

Friction in gear box caused by timber sagging on gear wheel.

Boiler 2

Overheating of woodwork around boiler stack.

Hot gases from economizer ignited wooden frame in window, owing to imperfect cut-off wall.

Workmen's Clothes 2

Ignited spontaneously from hanging against wall.

Spontaneous ignition of oily overalls.

Matches 1

Engineer lighted match to light lamp and head of match flew off into some raw material.

Lightning 1

Plant had been struck three times within two years by discharge entering over private telephone wires, but owners had failed to provide lightning arresters.

Smoking by Watchman 1

Rubbish 1

Spontaneous ignition of a pile of sweepings which were in boiler room to be burned.

Miscellaneous 1

Sun focused on yarn through a bubble in the window glass.

Special Hazards.

Picking 42
- Friction in picker (kind not noted) 19
- Foreign substance in rag picker 4
- Friction in carpet rag picker 2
- Friction in wool picker.
- Friction in jute waste picker.
- Foreign substance in jute waste picker.
- Friction in waste picker.
- Friction in mixed stock picker.
- Friction in finishing picker.
- Foreign substance in finishing picker.
- Friction in opener picker.
- Foreign substance in wool being run through picker ignited wool in gauze room.
- Foreign substance in linters and combers stock which was passing through lumper picker.
- Friction in breaker picker.
- Friction in stock blower.
- Foreign substance passing through picker in railroad waste containing considerable cotton.
- Foreign substance passing through rag picker communicated to loose stock.
- Foreign substance passing through finishing picker set fire to stock and frame partition of gauze box.
- It was supposed that fire was carried from the picker room to the stock bin in carding room in sheets of stock while the blower system was temporarily out of service owing to a slight fire in picker.
- Spark from emery wheel while grinding off teeth of rag picker cylinder landed in stock of burlap bags.

Carding 22
- Foreign substance in breaker card 5
- Friction 5
- Friction in feed rolls 4
- Foreign substance in Bramwell feed 3
- Foreign substance in breaker card originated at licker-in roll ... 2
- Foreign substance in card 2
- Originated in first breaker card probably from spontaneous ignition, as cards were not in operation.

Drying 11
- Exact cause not definitely ascertained 2
- Ignition of inflammable yarn stock and rubbish which had accumulated on live steam piping on floor of dry room.

Hot journal on inside bearings of fan in a home-made dry box through which finished carpet was passed.
Overheated journal.
Steam heated dryer may have charred woodwork which smouldered for some time.
Spontaneous combustion in fly or lint inside dryer.
Blade of fan became loose and struck against iron support casing.
Pole on which some yarn was suspended while passing through drying box broke and allowed yarn to come in contact with hot steam pipes.
Spontaneous combustion of stock in dryer.
Spontaneous ignition of cotton lint.

Stock.....23

Raw 5

Spontaneous combustion in pile of loose stock in picker house.
Spontaneous ignition in pile of stock which had not been willowed; stock consisted principally of hair with some ingrain carpet waste and about three percent cotton. Stock had not been oiled and was in front of willow ready for dusting.
Spontaneous ignition of baled sliver (carded jute).
Spontaneous ignition in baled jute.
Spontaneous combustion in raw stock of cattle hair, cotton and jute, in picker room floor.

Waste 5

Spontaneous ignition of dirty cotton waste in a mixing of 20,000 pounds.
Spontaneous ignition in a bale of waste which had been brought into factory the day before.
Sweepings from card and mule rooms ignited spontaneously in waste stock box.
Cotton, woolen and mixed waste from mills, also hair and old carpet stock in storehouse.
Fire started in pile of card waste and loose stock on floor in card room.

Yarn 13

Spontaneous ignition of dyed cotton yarn.....4
Spontaneous ignition of dyed jute yarn.....2
Spontaneous ignition of dyed mixed yarns (cotton, jute, etc.).2
Spontaneous ignition in dyed chenille yarn.....2
Spontaneous ignition of dyed cotton and wool yarns stored in racks.
Spontaneous ignition in bale of cotton warp yarn.
Spontaneous ignition of freshly dyed Merino yarns.

Dusting and Willowing.....4
Match or foreign substance in stock passing through willower.. 2
Foreign substance in duster.
Friction in machine.
Weaving..... 4
Cord in harness of Jacquard loom broke and fell across open gas jet.
Friction in loom.
Warp ignited in unknown manner.
Spark set fire to cotton warp in loom.
Spinning..... 1
Friction in mule carriage.
Garnetting 1
Friction.
Finishing 1
Spark from hot bearing on napper ignited dust above machine.

Exposure.

Fire communicated to main mill and boiler house from an unprotected yarn shed.

Unknown.

Fire said to have been discovered by watchman around the boiler, perhaps through carelessness with ashes and unacknowledged carelessness on part of the watchman.

Hard to determine whether spontaneous combustion in belt box or heat from steam pipe which was along side of box.

Occurred in dry room adjoining boiler room.

Occurred in one-story brick enclosed dry room with earth floor and mill roof, steam pipes on floor.

No cause apparent.

End of mill and picker house all ablaze when discovered.

Started in an unsprinklered closet in office which contained books and papers and a few garments hung there.

Occurred in closet in office.

Of unknown origin, set fire to stock in picker room.

Fire occurred on top of a pile of rugs which were stored on end and reached nearly to the ceiling. There were no electric wires, and the one steam pipe which passed near this point was fully protected with asbestos covering.

Special Details of Common Hazards.

This fire was discovered near an iron stack that passed through roof of boiler room, and was probably due to the overheating of woodwork around the stack. The stack was six inches from the woodwork and the bonnets also seemed to fit closer to the collar than usual, and probably sufficient ventilation was not afforded.

Fire started in slatted rack about three feet square which ran to

ceiling. The rack contained fast black stock. The steam pipes were properly protected where they passed back of rack. The records showed watchman registered on a station twenty feet from rack and did not notice any fire. There was evidence that a broom was hanging from a nail on outside of rack, and the broom was partially burned. A similar broom was hung from the same nail and just touched the steam pipes. It was the judgment of inspector that the broom being oily and having more or less dirt and cotton lint on it from floor sweepings, took fire from being in contact with steam pipes. The outside of slatted rack also showed more char than the inside.

There was indication that this fire was caused by watchman smoking. Fire originated in pile of jute yarn. Watchman failed to discover fire and was unable to give a coherent story when questioned concerning the fire. A fire of similar nature occurred a short while previous.

Fire was caused by a swinging gas jet. The gas pipe was supported by a wire hanger at the ceiling. Owing to the vibration, this wire became loose and allowed the jet to ignite the loom harness.

Special Details of Special Hazards.

Fire occurred in dryer. This dryer was of frame construction, thirty-two by thirty-eight feet, and nine feet eight inches high. Steam pipes were laid horizontally on iron racks, and live steam was used which gave a temperature of over 180°. Brussels carpet was being dried after having been sized on underside by passing over these steam pipes, carried by means of rollers at ends of dryer. Steam was shut off at night and four pieces of carpet left in dryer. It is probable that the carpet would then sag and come in contact with steam pipes, which would, however, gradually cool off during the evening. Fire might also have been caused by fine fly which continually sifts out of the carpet and is cleaned out below. These dryers were hard to keep clean, as the fly lodged on the steam pipes.

The first breaker card in which fire originated had been running on dyed stock which was red, but not turkey red. Card had been cleaned and stripped the afternoon of the fire, in order to start on another color of stock the next morning. Card and floor are claimed to have been perfectly clean. Fire must have been caused by spontaneous ignition of this colored stock, and had undoubtedly been smouldering several hours before being discovered.

Probably spontaneous combustion in piles of sliver (carded jute). It was thought that the sliver became wet from snow blown through a window, and that spontaneous ignition resulted.

Fire occurred in a waste stock box containing the sweepings from the card and mule rooms. The sweepings were conveyed from the various floors by a blower system, fan being located in the mixing room. Stock box was constructed of one-inch pine boards, ventilated at the sides, the opening being covered by one-half inch wire mesh. The fire spread through this opening into the mixing room and ignited a mixed batch on the floor.

Fire occurred in a loom on which the machinist had been working. He had put on a new "ball and stud," which was a small fitting driving part of a loom. It was thought that this part was screwed up too tightly, and after loom had been in operation about an hour this fitting became hot enough to set fire to the fly which had accumulated on the machinery.

A stock consisting of seventy-five per cent of "buffer" (the pickered wool carpet) and twenty-five per cent of brown cattle hair was passed through the Bramwell feed of card. Stock was mixed in picker house with lard oil, blown to stock box in card room and placed in the Bramwell feed by hand. Undoubtedly some foreign matter was in the stock.

Fire originated in a Lorimer cyclone dryer and was discovered by employee who was about to start the dryer in the morning. It was thought fire originated from rubbish or woodwork coming in contact with steam pipes.

Fire started in Lorimer cyclone dryer. Dryer had been used just previous to the fire for drying red dyed jute yarns. It was the practice before shutting down this machine at noon and night to run through all the stock contained in it to avoid the possibility of overheating. As fire occurred after the noon shut-down, perhaps this may not have been done at that time. Fire may have originated from that cause.

Fire was carried through blower pipe from picker room to stock box in card room and thence over cards.

Fire occurred among bundles of yarn on racks, which was all dyed yarn, some reds, greens, etc. Some had been in building several weeks, but some of the green yarn had been brought in a day or two before fire. It was thought that fire was caused by spontaneous combustion in some of this yarn, due to the dyes.

Spontaneous ignition in pile of stock which had not been willowed. Stock consisted principally of hair, with some ingrain carpet waste and about three per cent cotton. Stock had not been oiled and was in front of willow ready for dusting.

Supposed that a card in harness of Jacquard loom broke and fell across open gas jet, fire spreading to harness on loom.

Pole on which some yarn was suspended while passing through drying box broke and allowed yarn to come in contact with hot steam pipes.

It was supposed that fire was carried from the picker room to the stock bin in carding room in sheets of stock while the blower system was temporarily out of service owing to a slight fire in picker.

Spontaneous ignition of freshly dried merino yarns. Eleven hundred skeins on rack received from dryer day before and probably was not dried or seasoned.

Spontaneous ignition in pile of chenille jute yarn in rack in basement. Claimed to have been there four months. No heat or light near. Pile four by five feet high. Fire confined to this pile.

Foreign substance in stock produced a flash fire in same while passing through card, and extended to loose inflammable stock with which floor was littered.

2. MISCELLANEOUS STATISTICS.

Class of Factory Where Fire Occurred.

Carpet yarns only.....72 fires, or 52 per cent.
Full process carpet factories.....66 fires, or 48 per cent.

Amount of Losses.

	Sprinklered.		Unsprinklered.		Total.	Per cent of total.
	No. of Fires.	Per cent of Sprinklered.	No. of Fires.	Per cent of Unsprinklered.		
None	39	32.5	2	11	41	29.7
Small	69	57.5	12	67	81	58.7
Large	12	10	4	22	16	11.6
Total	120		18		138	

Losses as Compared to General Causes.

Common hazard fires caused losses as follows: No loss, twenty-eight per cent; small loss, fifty-five per cent; and large loss, seventeen per cent.

Special hazard fires caused losses as follows: No loss, thirty-one per cent; small loss, sixty-two per cent; and large loss, seven per cent.

Fires of unknown origin: No loss, ten per cent; small, fifty per cent; large, forty per cent.

Relation Between Effect of Sprinklers and Losses.

In the cases where fire was practically or entirely extinguished, forty-two per cent resulted in no loss, and fifty-seven per cent resulted in small loss. There was one case where the loss was large. This fire occurred on second floor, due to spontaneous ignition of dyed yarns. Sixteen sprinklers operated with a pressure of twelve pounds. A loss of $5,500 resulted.

In the cases where fire was held in check, twelve per cent resulted in no loss, seventy-three per cent in small loss and fifteen per cent in large loss.

In the cases where fire was not satisfactorily held by the sprinklers, a large loss resulted in every case.

Inside Protection Equipment Used.

(In sixty-five cases)

Pails.....44 Chemical Extinguishers.....19
Hand Hose.....15 Standpipes.....20

In nineteen cases (included above) there was more than one kind of inside protection equipment used.

Inside protection equipment was used in sixty-one per cent of the cases where the sprinklers entirely or practically extinguished the fire, in fifty-five per cent where the sprinklers held fire in check, and in thirty-three per cent of the cases where work of the sprinklers was unsatisfactory.

In seven cases the fire was extinguished before any sprinklers operated. Details as follows:

Pails used, no loss, two cases.

Pails used, small loss, three cases.

Pails and chemical extinguishers used, no loss, one case.

Public fire department used hose stream, no loss, one case.

Inside protection equipment was used in sixty per cent of the cases where no loss resulted, in fifty-eight per cent of the cases where a small loss resulted, and in fifty per cent of the cases where a large loss resulted.

Outside Protection Equipment Used.

(Forty-seven cases)

Private.....26 Public.....41

Both public and private used (included above).....8

In eleven cases public department used chemicals only.

Outside protection equipment was used in twenty per cent of the cases where the sprinklers entirely or practically extinguished the fire, in seventy-six per cent where the sprinklers held fire in check, and in every case where the sprinklers failed to hold the fire satisfactorily.

Public protection equipment was used in eighty-six per cent of the cases where no loss resulted, in fifty per cent of the cases where the loss was small, and in eighty-three per cent of the cases where the loss was large.

Inside and Outside Protection Equipment.

There were twenty-five fires that were practically or entirely extinguished by the sprinklers in which no inside or outside protection equipment was used, or thirty-four per cent of these fires.

3. ROOMS IN WHICH FIRE OCCURRED.

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Picker House	1	5.5	45	41.3	1	9.1	47	34
Carding	1	5.5	26	23.8	1	9.1	28	20
Storage or Stock Rooms	6	33.3	14	12.8	2	18.2	22	16
Drying	1	5.5	9	8.3	2	18.2	12	8.8
Weaving	2	11.1	7	6.4	..	..	9	6.5
Boiler Room	2	11.1	..	..	1	9.1	3	2.2
Office	1	5.5	..	..	2	18.2	3	2.2
Engine Room	2	11.1	..	..	..	..	2	1.5
Dusting	..	..	2	1.8	..	..	2	1.5
Finishing	..	..	2	1.8	..	..	2	1.5
Beaming Room	..	..	1	.9	..	..	1	.7
Cutting Room	1	5.5	..	..	..	..	1	.7
Dye House	..	..	1	.9	..	..	1	.7
Garnett Room	..	..	1	.9	..	..	1	.7
Spinning Room	..	..	1	.9	..	..	1	.7
Fourth Floor	1	5.5	..	..	..	..	1	.8
(Occupancy not given)								
No data	..	..	..	..	2	18.2	2	1.5
Total	18	99.6	109	99.6	11	100.1	138	100.0

4. DAY OR NIGHT FIRES. (Day Fires 6 a. m. to 6 p. m.)

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Day	11	62	91	84	2	18	104	75
Night	7	38	18	16	9	82	34	25
Total	18		109		11		138	

5. PLANT IN OPERATION.

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Plant in operation	11	62	88	81	3	27	102	74
Plant not in operation	7	38	21	19	8	73	36	26
Total	18		109		11		138	

6. HOW DISCOVERED.

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Employee	10	55.5	89	81.5	3	27.3	102	73.9
Watchman	4	22.2	11	10.1	4	36.4	19	13.8
Sprinkler Alarm	3	16.7	6	5.5	..	..	9	6.5
Outsider	1	5.5	3	2.8	4	36.4	8	5.8
Total	18		109		11		138	

SPRINKLER FIRE RECORD.

7. EFFECT OF SPRINKLERS.

	No. of Fires.	Per Cent of Whole.
Extinguished or practically extinguished fire	74	61.7
Held fire in check	33	27.5
Unsatisfactory	6	5.
Fires extinguished before sprinklers operated	7	5.8
Total	120	
No claim	39	32.5
Small loss	69	57.5
Large loss	12	10
Total	120	

8. DETAILS OF UNSATISFACTORY SPRINKLER FIRES.

S-11660. There was a small 4-story ell at southwest corner of factory, 14 x 24 feet. The company had their office third floor and stored carpet yarn in racks fourth floor. Fire occurred in this yarn. There was a frame enclosed stairway in this ell with 1-inch partitions and 1-inch doors at foot of stairway each floor. At time of fire there was 4,000 pounds of carpet yarn stored in racks, and some on spools and beams. Yarn was about 3,400 pounds wool and 600 pounds cotton. There was one rack of yarn two feet or more deep against south wall of building and a double rack in middle of room, running east and west. Beams were stored on a rack against north wall and there were some spools of yarn in bags at foot of this beam rack. Sprinklers were located over the aisles between these yarn racks, etc., but were spaced too wide across joists (10 feet), and the 4 sprinklers in room 20 x 14 feet were supplied by a 1¼-inch riser.

Yarn was said to have been kept about eighteen inches below joists and not packed up solidly into tops of racks.

There were no cut-offs between ell and main building, there being full size openings each floor. Floors of main building and ell were double. The afternoon before fire there had been only two or three hands working in fourth floor, and these men went out about 5.30 or 5.45 p. m. A member of the firm made a round later, before shutting up, and found everything all right.

Mill opened at 7 a. m., and one of the firm came up to office in third floor of ell and then went around third floor of main building, but did not go up into fourth floor, and none of the hands went up into this floor.

A few minutes before 8 a. m. employees heard sprinkler alarm ringing. An outsider turned in an alarm and department was soon on the scene. By this time the yarn room in fourth floor of ell was a seething mass of flames, the four sprinklers apparently having little effect on the fire, and roof soon burned through in one corner. The department put in a couple of streams and soon had fire under control.

About fifteen minutes after reaching factory they ordered engineer to shut off sprinkler system, and this was done by closing valve in engine room. Fire was extinguished in about an hour.

The yarn room in fourth floor was badly burned out; window frames burned out and roof heavily charred and burned through in small part. Part of the yarn was consumed and the balance burned in spots and all wet down. Some of the spools were consumed.

The heat poured out of the burning fourth floor of ell into fourth floor main building, under the low gable roof, and opened 14 sprinklers, which was one less than all the sprinklers there. These sprinklers were supplied by 2-inch riser in south end of building.

It appeared that fire originated low down among the bundles of yarn on racks where sprinklers could not reach it. Fire probably smouldered

and spread among the yarn, generating sufficient heat to open sprinklers in ell and main building, and with 18 sprinklers in operation, water pressure was so drawn down that each sprinkler delivered only a small amount of water, and the 4 sprinklers in ell were unable to hold fire. Conditions were made worse owing to the fact that fire was in top floor of building, where pressure on sprinklers was only 12 pounds, supplied by a 7,500-gallon gravity tank.

Owners could give no explanation as to the origin of fire. Stock was all dyed yarn, some reds, greens, etc., and while some had been in risk several weeks, some of the green yarn had been brought in a day or two before fire. It is possible fire was caused by spontaneous ignition in some of this yarn, due to the dyes.

Fires in racks of carpet yarn are comparatively common occurrences.

It is probable fire had been smouldering some time, and had some one gone into fourth floor on first entering mill about 7 a. m., it would have been discovered. It is probable also that sprinkler alarm was slow in operating, so that one or two sprinklers might have been in operation several minutes before bell began ringing.

Summary: Obstructions to distribution.

2198. This was a two-story brick mill of open joist construction. Floors were single boards. Fire started on second floor inside or around main belt box in card room. It spread over entire floor and worked into engine room through the belt box.

Mill was equipped mostly with Walworth soldered deflector sprinklers, supplied by a 2,600-gallon gravity tank which gave a pressure of seven pounds on the heads which operated. The sprinklers had apparently no effect whatever. Tank was probably drained in a very few minutes.

Summary: Deficient primary supply, both as to pressure and quantity.

3033. This was a brick factory of mill construction. Fire occurred in top floor, used for carding and spinning cotton carpet yarn. There were 78 Issue C Grinnell metal disc sprinklers in room, supplied by a 5,000-gallon gravity tank, which gave a static pressure of nine pounds. Fire originated on card and spread so rapidly that employees, who were attempting to fight flames with pails, chemical extinguishers and two standpipe streams, were forced to leave. All the sprinklers opened and failed to hold the fire. A large number probably opened immediately, which soon exhausted the tank. The timely arrival of the fire department prevented a total loss, and the fire was confined mostly to the top floor.

Summary: Deficient primary supply, both as to pressure and quantity.

6136. Factory was destroyed. After fire, the three inside gate valves were found closed, so that the sprinkler system was not in service. The management was reported as slack and the care of fire appliances poor. It appeared that the sprinkler equipment was not properly maintained.

Summary: Water shut off sprinklers.

9275. Story of this loss was given in QUARTERLY, Volume 4, Number 3, page 368.

Summary: Water shut off for unknown reason.

10311. Story of this loss was given in QUARTERLY, Volume 4, Number 2, page 208.

Summary: Unsprinklered portions.

9. DETAILS OF LARGE LOSS SPRINKLER FIRES. (Where sprinkler control was satisfactory.)

4464. At 11 a. m. a fire occurred on the upper story of a three-story and basement brick mill constructed building. Occupancy consisted of about 30,000 pounds of colored wool and yarn in skeins and on cops, 7,000 pounds chenille, and a quantity of rugs, all on racks. In one corner of the room there were four small closets, each about three by four feet, with shelves which contained some 2,500 cut designs ready for use by the weavers on the Jacquard looms.

The fire was discovered by a weaver entering the room to change a cop. He saw the smoke coming from the closets and endeavored to extinguish the fire by using a number of fire pails, but finding that it was rapidly gaining headway, he gave the alarm. By the time help had arrived, the closets were all on fire, and smoke quickly drove the men from the room. Several sprinklers were in operation by this time. The public fire department arrived within ten minutes and carried a line of hose attached to a street hydrant up through the stair tower. The chief assumed entire charge, and presently thinking he had the fire under control, ordered the water shut off the sprinkler system. By so doing he made a mistake, for in a few moments he saw the fire was increasing, and ordered the water turned on again. During this interval, perhaps seven minutes, while the sprinkler system was shut off, the heat passed down the room, opening every head, forty-six in all, so that when the water was turned on again the room was flooded, and the water leaking through the floors wet the contents of the entire building below to the basement.

This factory was equipped with a wet-pipe system of Grinnell glass button automatic sprinklers, supplied by connection with a twelve-inch street main and a 720-gallon Buffalo Underwriters steam fire pump, taking suction from a 70,000 underground cistern in yard.

The cause of the fire was unknown. The closets were clean. No electric wires passed through them and the current was not on. There was no machinery in the room and no oily waste likely to be there. Mice and matches were suggested, but no nests were found when the bottoms of the closets were turned out.

Had there been a standpipe and hose on this floor, also waterproof covers for the stock, it would appear that a lot of the damage could have been prevented. Loss between $10,000 and $12,000.

Lessons to be learned from this fire: Make sure that the fire is under control before turning the water off the sprinkler system. If necessary to turn the water on the second time, more heads are likely to be opened and the water damage greater. The importance of having sprinklers in all closets or concealed places. Public fire departments should be educated as to the principles of automatic sprinkler systems.

10008. Fire occurred on third floor of main mill in carding room, due to friction in first breaker. Fire spread to stock box, thence to seven other cards. Seams in flooring allowed fire to gain access to a mule carriage on fourth.

Plant was equipped with International sprinklers, supplied by waterworks at a pressure of 100 pounds. The sprinklers very effectively held fire in check, but a loss of $7,600 resulted.

5963. Fire started in first story of a four-story brick building of standard mill construction, and cut off from the remainder of the property by wood, tin-clad, non-standard fire doors.

The fire occurred when the weather was very unfavorable, as a blizzard was raging. It was first noticed by smoke coming up through the floor to second story, where the office was located. One of the clerks immediately called the fire department by telephone. Before the fire department arrived, the fire pump was started and the following hose streams applied to the fire: In the first story, two one and one-eighth inch streams from private hydrants and three three-eighths inch hand hose streams from sprinkler system.

Plant was equipped with Grinnell glass button sprinklers, supplied by waterworks which gave a pressure of forty pounds on the sprinklers that operated. The secondary supply, consisting of a 750-gallon Underwriters pump, maintained a pressure of seventy-five pounds on the sprinklers. There were sixty-three heads in the room and forty-five opened. The fire occurred in baled sliver (carded jute), probably from spontaneous combustion. Jute was piled seven bales deep on sides.

The fire department took charge upon its arrival and immediately cut a hole through the floor. They used the factory hose streams until their own could be placed in operation. A line of 4-inch hose 1,000 feet long was run from fire boat, and they threw an immense amount of water into the first story with a large spray nozzle. A horse was called into action for dragging this line of hose to scene of fire. The three city hose streams and two private ones were kept in operation from 9.30 a. m. until 1 p. m. It was reported that the fire patrol shut off the sprinklers after they had held the fire in check, so that the hose streams could be used to better advantage. The jute valued at $13,539.50 and finished goods valued at $6,387.08, located in the first story, suffered from the fire and water, and the latter ran into the size room adjoining and damaged carpets and starch which rested on the floor. The floor was brick and not arranged to drain. The water was swept away to drain as fast as possible.

The sprinklers performed the work expected of them, as was shown by the ceiling, which was charred except immediately above the heads. Serious losses must be expected so long as finished goods and jute are stored together. A large loss resulted.

6010. This was a six-story factory of standard mill construction. It was equipped with Grinnell glass button sprinklers, supplied by a gravity tank which gave a pressure of twenty-three pounds on the heads that operated.

At 10.30 a. m. a fire occurred in the stock room on the fourth floor of No. 7 building. The fire started back of a large rack filled with rags which were covered with burlap, and was probably caused by the ends of the covering coming in contact with live steam pipes. Eight sprinklers opened, and with the assistance of one hose stream and pails of water the fire was extinguished in half an hour. The fire did not spread beyond the room in which it originated, but the water ran through all the floors of the building and a large number of rugs were badly damaged. Loss $23,613.

S-11180. April 4, 1911. Fire was first seen in first floor of No. 2 wing, and was discovered by the engineer, who saw smoke pouring through the belt hole in first floor of fire wall between No. 1 and No. 2 buildings, as he was oiling up engine and wheel during the noon hour. Fire probably started in Lorimer cyclone dryer. On August 3, 1910, an almost identical fire occurred at this same plant, which was described under File No. 10.311, in Vol. 4, No. 2, page 208, of the QUARTERLY.

In the first floor of this building were also located two wool washers and one centrifugal dryer or separator. Dryer had been used during the morning for drying red dyed jute yarns. It was the practice before shutting down this machine at noon and night to run through all the stock contained in it, to avoid the possibility of overheating. This may not have been done at this time, and fire may have originated from this cause.

The fire spread rapidly into the adjoining dye house section, which was not sprinklered, and badly gutted it; passed through the roof of dye house and into the windows of the upper stories of the No. 2 building, communicating through the boxed cornice and also angle windows into the upper story and attic of No. 1 mill. This portion of the No. 1 mill was not sprinklered and was of the old type pitch lantern roof construction, joist plaster finish. This inferior type of roof construction, together with the strong east wind, resulted in the complete destruction of the roof and top story of No. 1 mill.

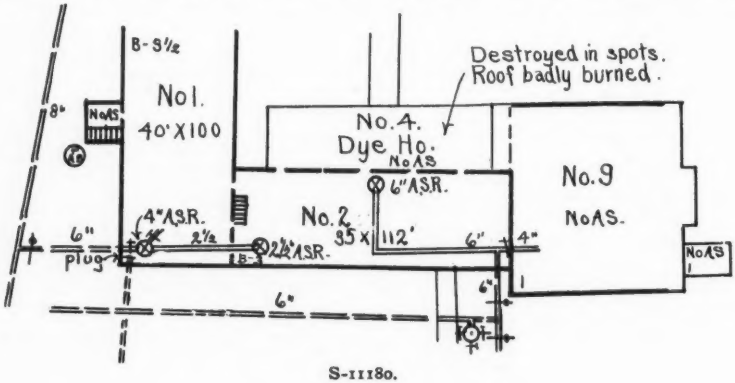
There were no sprinklers in the two lower stories of No. 2 wing, and the two upper stories of this wing had only a partial equipment. All sprinklers affected by this fire were Grinnell glass button.

There were 14 sprinklers in top story of No. 2, all of which opened, and 24 heads on third floor of No. 2, of which 8 heads opened. There was heavy fire damage first floor No. 2 and mostly water damage on second and third floors, and heavy fire damage on fourth floor, with roof demolished.

Sprinkler protection was only partial and pipe sizes and spacing were poor.

No. 1 mill afforded an interesting example of sprinkler protection. The basement, first and second stories were sprinklered, third story and attic were not sprinklered. Roof and attic floor were completely demolished, and third floor badly damaged. There was practically no fire damage below third floor, although entire mill was badly wet down.

Two sprinklers opened in basement of No. 1 mill opposite belt hole in fire wall. Two sprinklers opened first floor No. 1, one opposite angle window and one opposite fire door. One sprinkler opened second floor



S-11180.

opposite stair tower. There were no sprinklers in stair tower, and the interior of this tower was completely gutted, the fire working down from the roof through the entire tower.

The fire was effectually prevented from entering No. 1 building by the sprinklers (with the assistance of the fire wall), in the portions of the building which were so equipped. Sprinklers were supplied by waterworks, with pressure of 85 pounds. A 1,000-gallon steam fire pump did excellent service. There were 11 hose streams in use, supplied by the fire pump, private hydrants on the waterworks system, and one steamer.

Loss, $51,723.

Points of Interest Brought Out by this Fire.

1. Need of standard sprinkler equipment throughout entire property.
2. Stock dryers should not be built of wood and should be sprinklered inside.
3. Fire walls should be parapetted and angle windows protected.
4. Old style pitch lantern roofs fall easy prey to fire.
5. Value of good steam pump of large capacity and good private outside protection was demonstrated.

10. POINTS OF INTEREST FROM FIRE REPORTS.

Alarm Service.

S-6159. Watchman had just been making his round and it is claimed had passed through room where fire occurred not five minutes before, but he was not provided with an approved clock system. He was seen to come out door at foot of stair tower a few minutes before fire was discovered. Watchman, however, failed to discover fire and was apparently unable to give a coherent story when questioned as to fire, and was discharged, as there had been a similar occurrence shortly before.

Watchmen should be men of reliability and intelligence. Standard service, even with clock, may be invalidated by lack of these qualities.

S-5207. Watchman's service was not standard. There was no clock, but rounds said to have been made. Fire discovered, however, by an outsider. Sprinkler alarm was mechanical type and probably run down.

Watchmen should be provided with approved clocks.

Automatic Sprinklers.

S-1658. The sprinklers in story above the picker room were disconnected, owing to changes and alterations that had been made. When the fire occurred the water was turned on, with excellent results.

S-10761. Sprinklers would have been more effective if they had been in an upright position.

S-10906. Floor beams built up of planks on edge, with about three quarters of an inch space between them. Fire penetrated this space where sprinklers could not be effective.

S-3957. Several heads in dry box which did not open were found to be covered with a thick layer of lint. One head which had opened was found plugged with a lump of earthy material, apparently from sediment in pipe.

S-2256. Water was turned off and fire started again. Valve was then opened and fire entirely extinguished by help of fire department.

Construction.

Cut Offs.

S-7500. Owing to imperfect cut-off wall, hot gases from fuel economizer at boiler ignited wooden window frame.

Fire Door.

H-403. Fire occurred in dry room adjacent to dye house. Engineer, who discovered fire, closed fire door between these sections, which kept the fire confined to dry room.

S-9636. Door opening between an unsprinklered wooden shed, where fire originated, and brick sprinklered picker house was protected by a good single tin-clad sliding fire door. Although the wood under the tin was charred on the shed side (where the tin was worn from rubbing against the brick wall), the door held the fire at this point.

Floor Openings.

S-3957. Fire started in dry box on second floor and soon spread through seven-foot fan hole to dry box on third floor.

S-2288. Floor was worn very thin and had numerous cracks through which the burning stock and water dropped to the floor below, where baled cotton, jute, shoddy, etc., was stored.

Fire Drill.

S-1974. When the hundred girls employed in the mill learned that the building was on fire, a wild rush was made for the stairs. Down this passageway the girls crowded, and but for the arrival of the police many might have been seriously injured. The policemen were compelled to drag the girls out one at a time, so closely were they crowded. Many of them fainted and had to be carried out.

This shows the necessity for efficient fire drills.

Inside Protection.

Chemical Extinguishers.

S-9782. Chemical extinguishers were very effective in extinguishing this card fire.

Pails and Chemical Extinguishers.

S-11114. Several hands in picker room attacked fire at once with pails and chemical extinguishers, and had it extinguished before sprinklers had time to operate.

Fire Pails.

S-8794. Superintendent happened to be standing near loom when fire occurred, and he quickly seized a fire pail and threw contents on fire. Employees followed this up by the use of six more pails. Fire was extinguished before sprinklers opened.

S-2945. Prompt action of employees in making use of fire pails prevented blaze gaining sufficient headway to open sprinkler directly over the loom where fire occurred.

Hand Hose.

S-2288. Burning stock, which passed through cracks in the floor, was prevented from igniting contents of floor below by means of a one and one-half inch hose attached to a private city connection.

S-2263. Before sprinklers opened, employees endeavored to use hand hose, but failed to get any water out of it. It was found later that part of the rubber lining had separated from the cotton tube and had doubled up in such a manner that it was impossible to get any water through it. This appeared to have been due to sweating, on account of hose being placed near exhaust steam pipe.

Stock Storage.

S-5207. This fire illustrated the importance of not allowing finished stock to be stored in same room with raw stock likely to produce a fire.

S-4853. Water ran from floor in basement of building where fire occurred into basement of adjoining building, and did considerable damage to stock there. Stock was not skidded.

11. NUMBER OF SPRINKLERS OPENED.

No. of Sprinklers Operating.	Extinguished Fire. No. of Fires.	Extinguished Fire. Per Cent.	Held Fire in Check. No. of Fires.	Held Fire in Check. Per Cent.	Unsatisfactory. No. of Fires.	Total. No. of Fires.	Total. Per Cent.	No. of Sprinklers Operating.	No. of Fires.	Per Cent of Whole.
1	23	31	2	6	..	25	22.1	1	25	22.1
2	19	25.6	3	9.1	..	22	19.5	2 or less	47	41.6
3	12	16.2	..	..	..	12	10.6	3 or less	59	52.2
4	3	4	2	6	..	5	4.4	4 or less	64	56.6
5	3	4	2	6	..	5	4.4	5 or less	69	61.1
6 to 9 inc.	6	8.1	5	15.2	..	11	9.7	Less than 10	80	70.8
10 to 24 inc.	7	9.5	14	42.4	1	22	19.5	Less than 25	102	90.3
25 to 49 inc.	1	1.3	5	15.2	2	8	7.1	Less than 50	110	97.3
50 and over	..	..	..	..	3	3	2.6	50 and over	3	2.6
Total	74		33		6	113				

Average number of sprinklers opened, not including unsatisfactory, 6.6.

12. ALARM SERVICE. Fires Satisfactorily Discovered by one Agency Alone. Failures not Included.

	No. of Fires.	Per Cent.
Watchman	16	16.3
Sprinkler alarm	8	8.2
Employee	70	71.4
Outsider	4	4.1
Total	98	

Efficiency of Alarm Service where More than One Agency was a Factor.

	Watchman. Satisfactory.	Watchman. Failure.	Sprinkler Alarm. Satisfactory.	Sprinkler Alarm. Failure.	Employee or Outsider.	Total.
Watchman and sprinkler alarm	3	..	2	1	..	3
Watchman and employee or outsider	1	2	..	..	3	3
Sprinkler alarm and employee or outsider . .	..	..	12	3	15	15
Watchman, sprinkler alarm and employee or outsider	..	1	..	1	1	1
						22

13. SECONDARY WATER SUPPLIES.

Summary.

There were only six fires, or five per cent, in which the secondary supply was a factor in the extinguishment. Of these, four were held in check, one was practically extinguished and one resulted in a failure. Four of these fires resulted in a small loss, and in two a large loss resulted. Both private and public outside protection equipment was used in five cases, the exception being in the third case where the sprinklers practically extinguished the fire.

Details.

1029. Primary water supply was gravity tank, which gave twenty pounds pressure on the first of twenty-nine sprinklers that operated. Steam pump was used. Fire held in check.

1030. Primary water supply was gravity tank, which gave twenty-five pounds pressure on the first of twenty-five sprinklers that operated. Steam pump was used. Fire held in check.

1073. Primary water supply was gravity tank, which gave thirty pounds pressure on the first of three sprinklers that operated. Steam pump was used. Fire practically extinguished.

4476. Primary water supply was waterworks, which gave seventy-five pounds on the first of seven sprinklers that operated. A 1,000-gallon steam pump was used. Fire held in check.

5963. Primary water supply was waterworks, which gave forty pounds pressure on the first of forty-five sprinklers that operated. A 750-gallon Underwriters steam pump maintained seventy-five pounds on sprinklers. Fire held in check.

10311. Primary water supply was waterworks, which gave about sixty pounds pressure on the first of thirty-six sprinklers which operated. No sprinklers where fire originated. A 1,000-gallon Underwriters steam pump maintained the pressure fairly well. Fire was not controlled by the sprinklers.

14. EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS.

Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Waterworks,	60	53.6	69.5	6.7	36.6	15.2	1.8	67.6	72.6	72.5	3.3	14.9
Gravity tank,	51	45.5	20.4	6.5	28.6	14.3	2.7	20.3	22.6	9.3	4.7	10.2
Pressure tank,	..	..	..	..	..	..	..	..	..	..	..	..
Automatic pump,	1	0.9	70.	6.0	0.9	..	..	70.0	..	..	6.0	..
Total,	112	100.0	47.2	6.6	66.0	29.5	4.5	47.2	49.0	34.6	3.9	12.6

15. EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Less than 15 lbs.,	12	10.7	11.6	7.4	4.4	3.6	2.7	11.6	13.3	9.3	7.8	7.0
15 to 24 inclusive,	26	23.2	19.4	5.7	17.8	5.3	..	19.5	19.2	..	4.3	10.7
25 to 49 inclusive,	27	24.1	32.1	8.6	16.1	8.0	..	31.0	33.3	..	3.0	19.4
50 and over,	47	42.0	80.4	5.8	27.7	12.5	1.8	80.0	82.0	72.5	3.5	10.7
Total,	112	100.0	47.2	6.6	66.0	29.5	4.5	47.2	49.0	34.6	3.9	12.6

16. EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS.

Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Wet system,	110	98.2	47.0	6.7	64.3	29.5	4.5	47.0	49.	34.6	3.9	12.6
Dry system,	2	1.8	55.0	4.0	1.8	..	..	55.0	..	..	4.0	..
Total,	112	100.0	47.2	6.6	66.0	29.5	4.5	47.2	49.	34.6	3.9	12.6

Note—"Average number of sprinklers opened" does not in any case include the Unsatisfactory fires.

17. EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS —As Regards Amount of Loss.

Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Waterworks,	60	53.6	69.5	6.7	17.0	31.3	5.4	60.3	75.7	66.2	3.3	5.5	33.3
Gravity tank,	51	45.5	20.4	6.5	13.4	27.7	4.5	21.3	21.2	12.6	3.5	7.6	12.0
Pressure tank,	..	..	..	..	..	..	..	..	..	..	..	..	..
Automatic pump,	1	0.9	70.0	6.0	0.9	..	..	70.0	..	..	6.0	..	..
Total,	112	100.0	47.2	6.6	31.3	58.9	9.8	43.9	50.1	40.2	3.5	6.5	26.2

18. EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS —As Regards Amount of Loss.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Less than 15 lbs.,	12	10.7	11.6	7.4	1.8	5.3	3.6	11.0	12.8	10.0	1.0	8.2	16.0
15 to 24 inclusive,	26	23.2	19.4	5.7	5.3	17.0	0.9	18.0	19.7	23.0	3.2	6.4	8.0
25 to 49 inclusive,	27	24.1	32.1	8.6	12.5	9.8	1.8	31.1	31.7	37.0	3.1	8.8	45.5
50 and over,	47	42.0	80.4	5.8	11.6	26.8	3.6	74.6	83.5	76.3	4.4	5.3	21.0
Total,	112	100.0	47.2	6.6	31.3	58.9	9.8	43.9	50.1	40.2	3.5	6.5	26.2

19. EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS. —As Regards Amount of Loss

Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Wet system,	110	98.2	47.0	6.7	29.5	58.9	9.8	43.2	50.1	40.2	3.5	6.5	26.2
Dry system,	2	1.8	55.0	4.0	1.8	..	..	55.0	..	..	4.0	..	..
Total,	112	100.0	47.2	6.6	31.3	58.9	9.8	43.9	50.1	40.2	3.5	6.5	26.2

Note—"Average number of sprinklers opened" does not in any case include the Unsatisfactory fires

GENERAL FIRE RECORD.

Unsatisfactory or Serious Fires in Buildings Equipped with Sprinklers.

Where sprinklers fail the cause is, almost invariably, clear. These fires are selected to indicate such causes, that they may be generally understood and satisfactorily met.

S-11576. Wood and Paper Box Factory.

Description of Plant.

This was a 3-story frame building about 50 x 80 feet, of open mill construction. Boiler plant was brick and cut off. There was a large frame detached sprinklered shavings vault and a long frame detached unsprinklered lumber shed.

Plant was equipped with Grinnell sprinklers, dry-pipe with Grinnell differential (No. 12) dry valve located in boiler room. Dry valve was connected to a rotary gong on building and to thermostat system. There were 289 heads on dry valve. Supplies, town water, 70 pounds pressure, 4-inch connection from 4-inch main fed two ways. Also 10,000-gallon gravity tank, 18 feet above top line.

There was also a Wall system of thermostats covering all but detached shed and connected to electric bell on building and at two dwellings.

Story of the Fire.

At about 1.15 a. m., Wednesday, November 22, 1911, the city night patrolman heard the rotary gong on factory ringing, and he promptly rang fire alarm box which was nearest to him, but several blocks from the factory. Shortly after, another person rang a box which was near the plant. The fire department responded with the auto chemical, carrying 1,000 feet of hose, and several hose carts. They stated that when they arrived both the first and second floors were ablaze. Two separate fires started on the first floor of main building. They laid two lengths of hose about 300 feet long, but found they had no effective pressure. The chief then shut off the city water supply to the sprinklers by means of city valve. Three more lengths of hose (about 300 feet) were then laid, two about 300 feet and one about 600 feet long. The fire was fought for over two hours before it was completely extinguished.

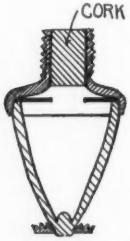
The electric bell on the building was also said to have rung, so it would seem that the connection from the dry valve operated properly.

The thermostat system apparently failed, and this was undoubtedly due to the test clock having been removed for repairs.

Fire number three was in the south end of a 1-story, frame joisted shed detached 40 feet, used for storage of lumber, and two automobile trucks. Sixty feet of this end was destroyed and both the trucks and the lumber practically ruined. All evidences of the causes of these fires were destroyed, but it was undoubtedly of incendiary origin.

Investigation of Fire.

An investigation to determine the reason why the sprinklers failed to hold this fire, disclosed the rather startling fact that while the sprinklers had opened properly in every place where there was indication of fire, a large percentage of them were plugged tightly, so that it was impossible for any water to pass through them.



CROSS SECTION OF SPRINKLER HEAD SHOWING CORK PLUG.

S-11576.

The plugging was done by means of corks, in most cases these being driven in tightly from the thread end of the sprinkler. Air or water pressure on the head simply forced the plug in more tightly. In some cases the plugs were of wood, and in one instance cotton waste was used. The appearance of all the plugs indicated that they had been in place for a considerable length of time.

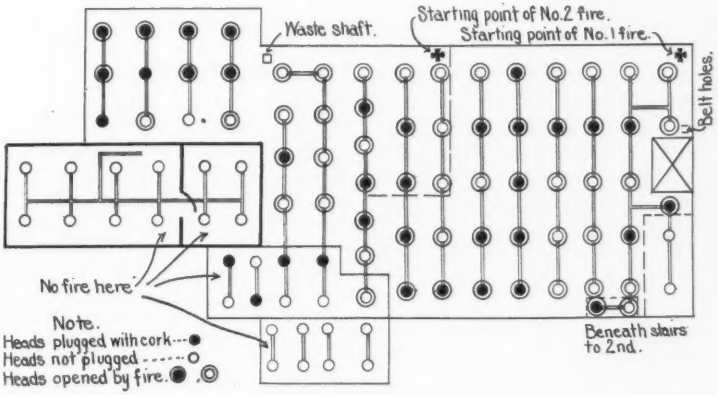
These plugs could be inserted only when the sprinkler heads were removed from the piping.

A fire occurred June 3, 1910, which opened about 85 heads, half on the first floor and half on the second floor. A comparison of the location of the plugged heads with the area of this fire, and also the fact that plugged heads were found on the third floor, where there was no fire in 1910, seemed to show that the plugged heads were not all put in after this fire. On the other hand, 29 of the plugged heads on the first floor, 11 on the second floor, and one on the third floor, were the latest model, thick deflector, made in 1910, and hence must have been plugged and installed during or since 1910. Also there were a large number of heads opened in the fire in 1910, and it was possible that some of these were plugged, which would account for so many heads being opened. If so, the man who removed the fused heads knew this, and said nothing about it. It seems probable that the man also put in the new sprinklers and was in a large degree responsible for the plugged heads.

When this condition was discovered the inspector went over every sprinkler head in the equipment, removing those found plugged for evidence. The accompanying cut shows the approximate location of all the heads, those opened by the fire, those found plugged and their location.

On the first floor 36 heads out of 97, or 36 per cent, were found plugged, while of 67 heads here in the main room where fire occurred 30 heads, or 46 per cent, were found plugged. On the second floor, 21 heads out of 67, or 31 per cent, were found plugged. On the third floor 8 heads out of 50, or 16 per cent, were found plugged. In the basement, where no fire occurred, all the heads were in proper condition and not plugged.

The fires appear to have been started simultaneously in three places, one in the southeast end of a 1-story frame lumber shed, located 40 feet west of the main building, one in the northeast corner of the first floor of



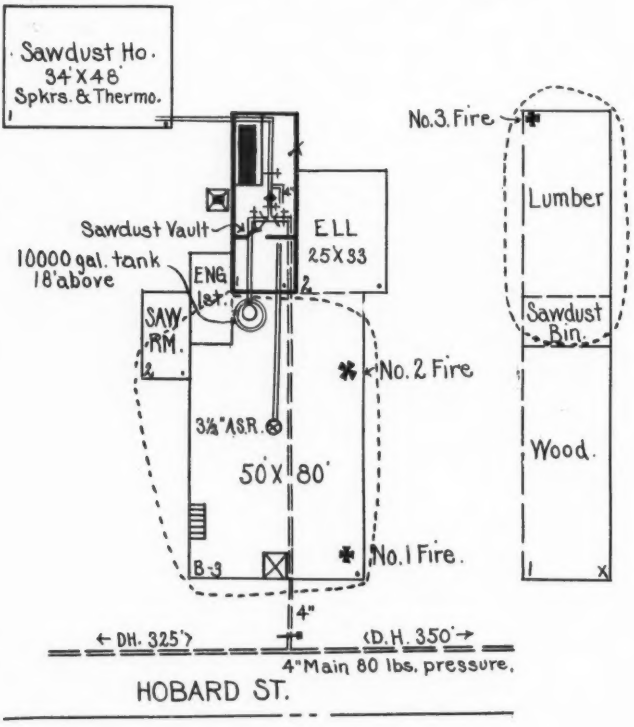
FIRST FLOOR

S-11576.

the main building, and one about 40 feet south of the last mentioned, just back of a frame partition. The fire in the corner of the first floor will be referred to as fire No. 1, the one 45 feet south on first floor as fire No. 2, and the one in the shed as fire No. 3.

At the starting point of fire No. 1 there were several piles of box shooks about six feet high on trucks. The smell of kerosene could be detected on these, also on some kegs of nails here, and was very noticeable on a bench of waste lying by the kegs. The waste, however, was not burned much. This would not have been the case had it been used to start the fire. A band saw used near here was run through kerosene, to keep it free from pitch, and one gallon of kerosene was usually kept here in an ordinary metal can. Kerosene was also used to clean a nailing machine near this, and it is possible that this waste was used to clean the machine and carelessly thrown away. The heads directly over the starting point of the fire were open and not plugged, though just outside this area there are a number of plugged heads.

At the starting point of fire No. 2 there were a number of baskets full of board ends for use as kindling wood. These appeared to have had kerosene on them, and a piece of kerosene soaked waste was also found near them. This, like the other piece of waste, was only partially burned. The heads just over the starting point of this fire were also open and not plugged, while just outside this area were some plugged heads.



S-11576.

The conditions were such, in both cases, that the fire probably spread very rapidly. The air pressure carried at this time was 55 pounds, which is excessive, as between 20 pounds and 30 pounds should be carried for this water pressure (70 pounds). The normal trip point of the dry valve is about 12 pounds at this pressure, and so there was a noticeable delay in the tripping of the dry valve after the sprinklers opened. This slight delay, coupled with the rapid spread of the fire, probably allowed it to spread to the areas where heads were plugged, and thus account for the sprinkler failure. It is also possible that the fire was set

in several places around the points of heaviest burning, and that kerosene was scattered more widely there than can now be seen.

Fire No. 1 passed up to the second floor through two belt holes, size 4 x 12 inches, burning off the seven-eighths inch enclosures on the second floor. The sprinklers directly over this were open and not plugged, but one just next to it was plugged. From here it went to the third floor through the windows, and perhaps partly through the elevator trap, which was partly broken. The elevator traps were single seven-eighths inch board, tin covered on lower side, with ordinary "T" hinges screwed on. The trap on the second floor held the fire well. The line of heads in the corner were plugged, giving the fire a good chance to spread here.

Fire No. 2 passed up to the second floor through a waste shaft, 18 x 18 inches, enclosed in single seven-eighths inch board which was burned through. Several sprinklers to the south of this point on second floor were plugged, although those to the north were open and not plugged. The roof of the 2-story addition at this point was about a foot higher than the third floor, and this space was shut off by single seven-eighths inch boards. These burned through and the fire passed up here. The heads over this point were plugged and the effect was noticeable, as the fire burned the roof considerably.

The firemen shut off the city water soon after they arrived and it is probable that this was soon after the fire reached the third floor. This is borne out by the fact that the glass discs on several heads on the side farthest from the fire, and which probably opened last, were not thrown off, but rested on the diaphragm.

The dry valve was taken apart and examined. The rubber disc was rather large, enough to rub somewhat against the sides of the valve body, which was covered by knobs of rust. It was in poor condition, rather soft and uneven. This would make it hard to set and to hold air, but would probably not affect its tripping.

In tests made recently, several dry valves in this condition were tripped with satisfactory results in every case. In one valve the sticking due to the size of the rubber disc was very much more pronounced, yet valve tripped properly.

It was said that this dry valve was found on the first latch after the fire, but this evidence was hardly of value, because some one had probably been looking the valve over, and moved it. This evidence seemed to show that the dry valve operated properly, except for a delay due to the excessive air pressure.

Water was found in the pipes on the first and second floors, proving the sprinklers did have water during the fire. The firemen also state that the sprinklers were operating when they arrived, but were not holding the fire.

The city water was shut off by the fire department a few minutes after they arrived, and the gravity tank then furnished water to the sprinklers until it was exhausted. This tank had been drained for repairs

the day before the fire, the repairs completed and the tank again filled. An icicle found hanging to the overflow pipe seemed to bear out this testimony.

To Summarize.

The failure of the sprinklers to hold this fire was due principally to the large percentage of plugged sprinklers on the first and second floors where the heaviest fire occurred. This was aided by the slight slowness of the dry valve in operating, due to the heavy air pressure carried, and by the quick spread of the fire, due to the nature of the contents and to the probable liberal use of kerosene in setting the fire.

S-11715

The small size of city main (4 inches), cement lined, with no larger main within 1,200 feet, together with the small size connection to the risk, gave a rather defective primary supply.

Poorly protected floor openings, though small, permitted the spread of fire from one floor to the other, after the sprinklers had failed to hold the fire. Loss about $20,000.

S-11715. Chair Factory. This fire destroyed the entire finishing plant and office. It was discovered by an employee who was at work in the office, and practically at the same time by the watchman who was making his eight o'clock round. The employee saw the reflection and ran to pull the fire whistle, and the watchman at the same time was crossing the open bridge between the machine building and the finishing building on the second floor. When the watchman opened the door of the finishing building he was severely burned by the burst of flame.

There were three other men at work in the mill, who came immediately, and two lines of hose were laid and played on the fire. The sprinkler alarm in that section had begun to ring before this. The employees living nearby came shortly. Ladders were raised and fire was apparently being held when the town fire department came and attached their engine to hydrant about three hundred feet from mill on same line which feeds the fire system in the plant.

The fire apparently started near a dip tank of golden oak stain on the second floor, near the entrance, it is thought from spontaneous ignition. The thinner used was benzine. The sprinklers opened in good shape and two lines of hose were quickly laid. These apparently checked the fire, as all flame disappeared, but great volumes of smoke continued to come from the building when suddenly the whole third floor seemed to burst out. The water had apparently driven the burning benzine back into the building and this gradually ate through the third floor. Efforts

S-11715.

were then turned to saving the balance of the plant. They were aided by a fair wind, which was blowing from the south and carried the heat and sparks directly from the plant to the open field at the north. The fire department laid two lines of about four hundred feet of two and one half inch cotton rubber-lined hose toward the plant, then inserted a three-way connection on each line and took off a total of six lines. These lines were 100 to 200 feet long. The hydrant to which the engine was attached was on a six-inch main. The engineer in charge of the steamer claimed at times there was no water. When the steamer went into action the pressure at the plant fell off, and these lines were probably fed by the tank only. The tank was eventually drained and considerably burned, the bottom being entirely consumed. The engineer informed the chief that there were too many lines out, but there was no change made. At last the number of lines was reduced to four and after that no trouble was experienced in obtaining sufficient water.

The sprinkler system consisted of Manufacturers Issue "C" heads, on modern pipe schedule. The static pressure on the sprinklers that operated was fifty pounds from waterworks. There was some obstruction to proper distribution from piles of chairs. Loss was total.

The failure of sprinklers to hold this fire at first seems to have been due to improper arrangement of a severe hazard. The final complete failure of system was caused by lack of water, due to the poor judgment on the part of the fire department in using so many hose streams, and the lack of an ample secondary supply.

Summary: Severe hazard and lack of water.

S-11706. October 30, 1911. Soft Fur Hat Factory. This plant consisted of a one to three-story frame factory of light construction. It was made up of three connected wings, which formed an irregular shaped building.

The watchman stated that he had completed the round made at 1.30 a. m., and had gone to the boiler room to fix his fires, when he heard two reports like light explosions coming from over his head. With his lantern he rushed to the room over the boilers and was unable to get into it on account of the fire. He then turned and ran to the fire alarm box several hundred feet away. Returning to the factory, he started to get out the hose located at the private hydrant, and with the help of neighbors succeeded in getting a stream on the fire.

The fire probably started with tremendous force and spread very rapidly, for the chief of the fire department said that when his tapper sounded the sky was all ablaze with light.

There were two rooms above the boilers, known as the dry rooms, although the lower one directly above the boilers was not used except by the employees in which to dry their wet clothes. The upper dry room had a slat floor and was full of hats in racks. These hats probably caused considerable obstruction to the distribution of the water.

The dye and plank shop, boiler room and the rear portion of the main building were completely destroyed and the roof of the main building and forming room were badly damaged. Loss about $45,000.

A very careful investigation was made of the unsatisfactory work of the sprinkler system at this fire. There was a fair water supply, and although the construction of the buildings was rather poor, a sprinkler system in good condition ought to have held the fire.

There were three possible causes for the unsatisfactory results:—

1. Obstructions in the pipes.
2. Failure of the dry pipe valve to operate promptly.
3. Defective sprinklers.

The following factors affecting the sprinklers seem to have all contributed to the loss of the factory:—

The fire started in poorly constructed dry rooms over the boilers. The floors were slatted so that the sprinklers were all in the same fire area. The construction of other parts of the plant was also poor.

Sprinklers cannot readily control a fire where there are vertical openings.

The dry rooms contained high test (300°) Walworth improved upright sprinklers. The Walworth sprinkler is one of the slowest to fuse and the 300° solder would make them very slow in action.

Tests and examinations of sprinklers taken from the ruins showed that some valve discs of the sprinklers stuck.

The sprinklers were on a dry pipe system with a Manufacturers' dry pipe valve. There were about 390 sprinklers on the system. This would tend to delay getting water upon the fire.

The delay in getting water on the fire from either or all of the above causes enabled the fire to spread rapidly, so that a very large number of sprinklers was finally opened, drawing heavily on the water supply. This, together with the somewhat restricted pipe sizes (1-2-4 schedule), would tend to reduce the pressure under which the sprinklers were operating. During the time that air was being exhausted, and while the water was flowing into the pipes (little or no pressure), many heads probably fused.

The tension in the sprinklers was found by test to be insufficient in many cases to free the links, so when water reached the sprinklers the links became wet or chilled by the cooling effect of neighboring sprinklers which opened properly. Many sprinklers which failed to open were found surrounded by heads which opened properly. Probably many sprinklers failed entirely, due to adhesion of the valve caps.

Undoubtedly the combination of high test heads, a dry pipe system and quick burning construction largely accounted for the rapid spread of the fire.

S-11598. Tenant Manufacturing. This was a four-story brick tenant factory, occupied on the top floor by a hosiery concern. Floors were of joist construction. Sprinkler equipment consisted of John Kane Universal heads on old standard pipe system, supplied by a 6,000-gallon gravity tank which gave a pressure of nine to ten pounds on the top line. There was no second supply. This was a wet-pipe system, provided with an old lever check connected to an outside electric gong, which apparently did not operate.

About thirty feet from west end of building on fourth floor was a frame partition extending to roof, but with a few inches of open space above partition. In the extreme northwest corner of room was located a small office, eleven by seven and one-half feet, with a passageway or vestibule four by seven and one-half feet on east side. Passageway opened out through north wall of building onto iron platform leading to stair tower. This passageway also opened into the office and into main room. At the east side of office was a small clothes closet and about at this point a door opened from office into main room. A roll-top desk stood at the west side of office against the partition. There was a space of about one foot between west partition of office and west wall of building. Partitions of office and vestibule were one-inch boards, part, however, being hard wood. There was a top or roof on office and passageway of one-inch boards. Office was formerly open at top, but had been

boarded over as noted and a flat skylight, about three by three feet, of double thick glass placed in top. A skylight in roof above gave a certain amount of light in office. Office was not equipped with sprinklers. The space above office, between top of office and roof, was piled up with finished hosiery, part in paper boxes and part in bundles. This shelf was the width of office, seven feet six inches, and had been extended east to frame partition, or about fourteen feet, making the whole platform twenty-nine by seven feet six inches. There was apparently a heavy stock here. There were no sprinklers below this shelf.

A member of the firm stated that the evening before the fire he had left factory about 5.45 to 6 p. m., with his superintendent, who was the only other person in their floor that afternoon. He shut down the top of the desk and left everything in good shape. Evidently the door from office out into room was standing open. These were the conditions leading up to the fire.

At 3.25 a. m. a couple of men, said to have been sleeping on a doorstep in the neighborhood, saw a bright light in fourth floor of mill, and ran to fire engine house, one block away, and gave the alarm. When fire department reached factory the fire had already burned through the roof. The fire department broke into top floor and attacked fire with a hose stream and soon had fire in roof out, after which chemical streams were used in extinguishing the fire around room and in stock.

The foreman of the nearest engine company stated that when they got into top floor there was a considerable amount of fire still burning among the stock of hosiery on the shelf noted and over roof of office; that roof was burned through for a space of about eight by nine feet, and on fire in other places; and no water was coming from sprinklers. Also that desk in office was burning freely and walls of office were on fire in places and articles of clothing in clothes closet, etc. Fire was evidently beginning to burn more freely, and had department not arrived promptly top floor would undoubtedly have been burned out and probably greater damage done. Department soon had fire extinguished.

There is every appearance that fire originated inside the roll-top desk, the top being closed. Fire evidently burned through the top of desk, spread to side walls of office and under side of roof, all of which were charred. In the meantime heat had flowed out the open door into main room, opening sprinklers at roof and gradually worked its way over partition and into east section and opened sprinklers here. These sprinklers gradually drained out the 6,000-gallon gravity tank, but could not reach seat of fire, and with the sprinklers out of service, fire gained rapid headway. It is said a large part of the finished stock above office was burned, and stock in other parts of room and some in cases on floor wet down. There was a large loss.

Summary: Unsprinklered portions and considerable obstruction to distribution.

Fire-Resistive Buildings—Fire Record.

These fires are selected to illustrate the behavior of various forms of fire-resistive construction under exposure to fire from within or without.

S-11705. Oilcloth and Linoleum Factory. (Complete details of fire given under same file number in section of Miscellaneous Fires.)

The dryer in which fire occurred was one of a compact group of twelve dryers of reinforced concrete construction. Fire occurred in building in the fourth dryer from west side. Each of these drying buildings, sometimes known as "stoves" or "cells," was 100 feet long, eleven feet six inches wide and fifty-eight feet high. Side walls were of reinforced concrete, six inches thick, the reinforcing consisting of three-eighths inch round rods, set twenty-four inches both ways, thus forming twenty-four inch squares. Every twenty-four to twenty-five feet these walls were strengthened by heavy reinforced concrete piers or buttresses, twelve inches thick, twenty-four inches wide at the bottom and tapering down to a width of one foot at a point forty-eight feet above floor. These buttresses were reinforced with two three-quarters inch rods running lengthwise (vertically) on each face or edge of buttress, these four rods being tied together by one-quarter inch rods or ties, set twelve-inch centers, the entire height of the buttress.

These buttresses were known as columns. The sidewalls were stiffened by reinforced concrete beams at right angles to dryers at the top of each buttress or column, making practically four such beams in each dryer. The mixture used in the concrete was one of Portland cement, two of sand and four of gravel. Roofs were formed of concrete slabs approximately four inches thick, reinforced in somewhat the same manner as the side walls. Roofs were supported on reinforced concrete beams and side walls.

There were four monitors, on each dryer, monitors being twenty-four feet long, three feet ten inches wide and six feet high. Walls of these monitors were of reinforced concrete and had wired glass in metal sash in one side only, so that the monitor windows from the same dryer faced each other, being four feet three inches apart. Metal sashes were set in metal frames and sashes were operated by levers and chains from the inside. Each of these monitors had a round sheet-iron ventilator in the top. The

partition wall between drying building No 27 and drying buildings adjoining on north, No. 30, was also of reinforced concrete, six inches thick. There was an opening about three feet by ten feet in this partition wall at a height of fifty to fifty-two feet above floor, which was protected by double standard, automatic drop doors. There were no openings in the east and west walls of the dryers. Fifty feet above concrete floor of dry rooms was a rack of two-inch iron pipes, which carry the linoleum in long festoons which hang down to a point three feet eight inches from floor. This rack of iron pipes was supported on reinforced concrete galleries two feet wide and two feet deep, attached to side walls. These galleries had a small opening in floor at south end, through which a link belt passed and which was also designed to drain the water from gallery. There were two drains in floor of dry rooms connected to sewer.

Adjoining drying building on south was a one-story brick building, No. 26, containing calender. This building was cut off from dryers by double standard fire doors, one being automatic.

The gallery floors noted were reached by outside iron stairways along south wall and had fire doors at each dryer, opening into galleries.

Walls between dryers were not parapet, but wall between No. 27 and 30 was parapet from one to five feet.

Details of Damage: The damage was very light. The interior of drying building was badly blackened and smoked at north end for a distance of perhaps twenty feet from the roof down. The entire roof was more or less blackened where fire was evidently hottest. At a few points near north end of building on side walls concrete was spalled in spots about as large as a silver dollar. At one point on east wall there was a streak three or four feet long, one-half to two inches wide and one-quarter to three-quarters inch deep where concrete had been spalled. This streak was probably where a joint occurred. There was also a little spalling on the under side of some of the concrete roof beams. This represented nearly the actual damage to concrete work of building.

The fire door in north wall at level of gallery was badly damaged, being bulged and out of its guides, but no tin came off. The wired glass and metal sashes and frames in sides of monitors, especially at north end, suffered severely from the heat, but apparently none of this wired glass melted. Most of it was, however, broken in by the firemen.

As nearly as can be learned, sheet metal sashes and frames in monitors were of approved make.

Sprinkler piping at ceiling of dryer was somewhat sagged and fittings in part were leaking slightly. Steam heating pipes and guard pipes at floor of dryer were bent for a distance of perhaps forty feet from the north end, where festoons of cloth fell on these pipes. It was thought that the pressure from the fire department hose streams from the roof, together with the weight of the water accumulating among the festoons of cloth, was partly what caused so much of this stock to fall.

H-6527. Storage Warehouse. This warehouse was seven stories high with basement, and the dimensions were forty by one hundred and fifty feet. Built of reinforced concrete construction with curtain walls of brick laid in Portland cement. Concrete was 1-2-4 mix with medium open hearth steel twisted bars. Floors and roofs made of reinforced concrete slabs. Roof covered with asphalt. Floors covered with cinder, conglomerate stairs and passenger elevators cut off. Large service elevator enclosed with concrete walls with unprotected doorways each floor. Windows all wire glass in standard metal frames. Division partitions for storage compartments were expanded metal, plastered solid with Portland cement on each floor except the sixth floor, where the storage was open.

A short time before noon some household goods were removed from the receiving platform to the sixth floor, where they were packed away. Fire was discovered in this lot of goods about 12.20, while the men were at lunch. It was believed that in moving this lot of goods the friction caused by handling them probably ignited some matches in the drawers of a dresser. This started a fire that was not evident at the time the men left their work, but which in a very few minutes developed into a sufficient blaze to communicate with some feather beds. These caused a smoke so dense that the firemen were unable to make their way through it from the elevator. Could they have done so, the fire might have been quenched with an extinguisher.

The fire was located about sixty feet from the elevator shaft, and in such a position that the only way to get to it was from the outside. The firemen were greatly delayed in getting ladders up to the sixth floor on account of some overhead wires in the street. When they finally reached a place where a stream of water could be used, it did not take long to extinguish the fire.

Out of nearly a hundred lots of goods that were stored on this floor, four lots were partially burned. This was practically the extent of the damage, other than that caused by water. The firemen left building about three o'clock in the afternoon, and owners had a large force at work immediately afterward, keeping them all night, and by the following morning hardly any trace of the fire could be seen. They had a large warehouse adjoining and all goods that showed any evidence of being wet were removed to this warehouse and opened, in most cases in the presence of the owner. After being thoroughly dried and laundered, they were put back in as good condition as formerly. Forty-eight hours after the fire goods were being stored on the floor where fire started and business was proceeding the same as usual.

The only damage to building was caused by the firemen, who broke some wired glass windows.

H-6587. June 26, 1911. Union Oil Company's Plant, Portland, Ore.

Construction. A one-story and basement concrete building erected several years ago. Area one hundred by two hundred feet. Walls were nine-inch concrete interwoven with Roebling wire. Basement floor concrete; first floor one and two inch plank, supporting three-inch concrete laid over Roebling wire. Truss roof covered with asphalt. Ceilings of basement and first floor fireproofed with metal lath and plaster. Interior loads were carried on a system of wood posts and girders fireproofed with metal lath and plaster. A concrete fire wall divided the building into sections of fifty by two hundred feet. This wall was eighteen inches in the basement and nine inches first floor. One communication, basement to first floor, was protected with double non-automatic tin-clad fire doors. There was a concrete partition wall dividing basement midway into equal sections.

The space in east end of south section of basement had been partitioned off with concrete walls; size of space forty by fifty feet, and contained four iron tanks used for the storage of gasolene, distillate, benzine, etc. Each tank held about 1,000 gallons of oil and was provided with a two-inch ventilating pipe in each end. These tanks were placed in sets of two and each set was surrounded with a nine-inch concrete wall with a seven-inch concrete ceiling above them, leaving a space between top of tanks and floor above of about four feet. This space was also provided with two two-inch ventilating pipes, which extended into the air about twenty-five feet. The balance of the space in front of these tanks was used for the pumps and motor. The roof over this space was concrete and formed floor to open space. A small corrugated iron room had been built on the floor of this open space and covered the stairs and opening leading to basement or pit where motors and pumps were located.

Cause. The cause of fire was not determined. The plant was in operation. It was claimed by the company that one of the employees had gone into the pit or space in front of oil tanks and started the motors which operate the oil pumps. He then left the pit, went up to the first floor, and walked through the building, It is just possible that the fire was caused from the blowing out of a fuse or possibly some defect in the motor equipment, etc.

Story of Fire. Owing to the floors being badly soaked with oil, the fire spread rapidly. An alarm was turned in at 7.50 a. m., Chief Campbell responding to the first alarm, and upon arriving at the plant sent in a general alarm at 8.05 a. m. The fire was never beyond the control of the fire department and was confined to the plant in which it occurred. It rained continuously during the progress of the fire. This was a very fortunate circumstance owing to the fact that the plant is adjoined on the south by that of the Standard Oil Company, where numerous large tanks of heating and illuminating oil were kept. It was also in close proximity to large frame buildings along the water front. The heat from the fire caused a considerable amount of gas to be generated, which accumulated in base-

ment. An explosion occurred, blowing about 125 feet of the north wall of the north section of the building into the street, also about 100 feet of the south wall of section C. As a number of firemen were standing in the street at the time, it was simply a miracle that many lives were not lost. Chief Campbell and Battalion Chief Young had entered the north section of the building, there being no fire in this building at that time. The explosion evidently knocked the Chief to the floor. It threw Chief Young some distance and he succeeded in getting out on East Water Street. When the wall fell out, the roof caved in and undoubtedly pinioned the Chief to the floor, and his charred remains were found floating in the water after the fire was under control.

Oil plants of this nature should be located outside of city limits or in a district remote from other buildings, even though of fire-resistive construction.

S-11459. June 13, 1911. Tenant Clothing Manufacturing. This was a brick building several stories high. Floors were constructed of concrete blocks sprung between steel I-beams, with cinder concrete filling. Maple flooring fastened to sleepers embedded in the concrete. Stairs in cut off tower. Building was equipped with automatic sprinklers throughout, supplied by two 7,500-gallon pressure tanks and a 20,000-gallon gravity tank. Static pressure on sprinklers that operated, seventy-five pounds.

Fire occurred on top floor at 8.12 p. m., caused either by gas being left on pressing iron or sparks from match used by employee to light a cigarette before leaving at 6 p. m Alarm given by alarm valve which was connected to central station. Fire department was notified, and responded. They found one sprinkler in operation, which was holding a small fire in check under the pressing table. Sprinkler system valve on floor was closed and fire extinguished with a hose stream. About 500 gallons of water from sprinkler and the water from hose stream worked down to the floor below through pipe holes in the floor at one corner, also down the side against brick wall where floor was fastened to the wall. Loss on building slight, on contents (mostly water damage) $1,775.

The necessity for, and effectiveness of, automatic sprinklers in buildings of this type was forcibly demonstrated. Care should be used to make floors tight at walls and around pipes. Floors should be scuppered to drain off the water.

S-11506. August 4, 1911. Wholesale Drug House. This was a sprinklered building of fireproof construction. Ceilings were smooth. Fire occurred on top floor, used for storage of dried herbs. Fire was discovered and alarm given by the watchman. Two sprinklers, supplied by gravity tank at pressure of eleven pounds, operated for about twenty minutes and extinguished fire. There was no loss on building; loss on contents about $3,000, mostly from water.

S-11466. June 16, 1911. Printing, Binding and Publishing House. This was a sprinklered building of fire-resistive construction. Floors were concrete arch, and beams formed pockets of four feet four inches to five feet by sixteen feet. Fire occurred in sub-basement among piles of rolled and flat paper. Sprinklers held fire in check and a stream from standpipe was used to complete the work. No loss to building; loss on contents, mostly from water, $3,000.

H-6648. July 19, 1911. Cleaning and Dyeing Establishment. This was a one-story concrete building, adjacent to a two-story wooden building. Concrete building had wired glass windows in wooden frames and wooden doors. There were two small rooms with concrete wall between; one used for gasolene cleaning and one for dyeing. Fire is thought to have been caused by spark from motor in area way between buildings igniting gasolene fumes. Fire consumed all the combustible contents of building, including the window frames and doors.

H-6527. June 12, 1911. Storage Warehouse. This was a seven-story reinforced concrete fire-resistive building. Fire occurred in a compartment containing household goods, and did not get beyond this compartment. Only damage sustained was the breaking of several wired glass windows by the firemen.

H-6501. January 28, 1911. Metal Worker. This was a concrete, fire-resistive building. Fire occurred in tinning room on fourth floor, caused by overheating of a small oil vat. It was extinguished by use of five chemical extinguishers and a hose stream from standpipe. Loss to building $10, and contents $5.

Miscellaneous Fires.

Interesting fires are given under this heading without regard to their classification.

S-11705. Oilcloth and Linoleum Factory. The construction of the linoleum dry rooms or "stoves," where fire occurred, is fully described in the report in the section on Fire-Resistive Buildings under same file number.

At the time of fire dry room was filled with what is known as cork carpet, hung in festoons on the iron pipe rack, fifty to fifty-two feet above floor. The capacity was about 10,000 square yards of linoleum, and at that time there was something under this amount of cork carpet in the dryer. Cork carpet may be described as a sort of thick linoleum, the composition or cement on the face of the burlap being about one-quarter inch thick; consequently such cloth does not hang very closely together in the dryers. The composition of the cement on coating on cork carpet consisted of ground cork, oxidized linseed oil, colors and possibly some gums, etc., the exact composition not being obtainable. The cloth (cork carpet) which was in dryer at time of fire was fed into dryer on the afternoon of the day previous to fire, so that cloth had been hanging in the dryer in the neighborhood of thirty hours when fire occurred. The composition had been forced onto the burlap on the calender in one-story building No. 28, adjoining dryers on south, and then fed into dryer in the usual manner. This cork carpet was colored a dark green.

Watchman was making his 9 p. m. round and had been on the ground floor of dryer in which fire occurred a little after 9 p. m. Watchman was said to have walked down to north end of dryer. He found everything in good order and no cloth broken down. The clock records on night of fire were perfect. Between 10 and 10.15 p. m. he heard sprinkler alarm on dryer No. 27 ringing, and soon located fire in the fourth dryer from west side. He at once called up the superintendent of plant and reported. He also called up the chief engineer of plant. Both were soon on the grounds. The engineer started the 1,000-gallon Blake fire pump, draughting from 122,000-gallon reservoir, which was supplied by a small stream and also by a six-inch, four-inch and eight-inch connection from a ten-inch, six-inch and a twelve-inch city main at about forty-eight pounds pressure. The latter was opened nearly wide and kept reservoir filled during fire. A pressure of 100 pounds was held on water end of pump.

It would appear that at this time only part of the sprinklers in dryer were open, as fire pump had no difficulty in maintaining this pressure, and

engineer therefore opened four-inch filling by-pass to 50,000-gallon gravity tank part way, so that part of the water went up into this tank.

The superintendent stated that soon after reaching plant he opened fire doors at ground level from building No. 26 into dryer, but was met with such a rush of smoke and a torrent of water pouring out, that he was compelled to close doors at once. This he accomplished with some difficulty.

While it was apparent that the sprinklers were holding fire down, inasmuch as up to this time no fire had actually been seen, nevertheless there seemed to be no way of entirely extinguishing fire except by entering dryer and hauling out the stock. This being more or less of a dangerous proceeding, superintendent sent a fire alarm from private box. The department was soon on the ground and as nearly as could be learned attempted to enter dryer at gallery floor, but the smoke and gases proved too dense. They next went up on the roof, guided by the superintendent, who wanted to make sure that water was not thrown into the wrong dryer, and broke in the wired glass windows in sides of monitors. Hose streams were then directed in through these windows, and fire showed evidence of being under control. The district engineer then ordered sprinklers shut off, and this was done by closing outside post gate valve. At this, however, fire again blazed up and, it is said, came out of the windows of monitor at north end of building. When district engineer saw flames coming up through monitors, he became afraid fire was getting out of the dryer, and accordingly he ordered a second alarm struck. This brought out considerable fire fighting apparatus. Sprinklers were accordingly turned on again and, as nearly as could be learned, were allowed to run at least an hour longer, the hose streams being used in the meantime.

About 1 a. m., or a little before, sprinklers were finally shut off, and soon after this fire again blazed up slightly, but was subdued by hose streams. By this time fire department was able to open fire doors at ground floor, south side, and enter the dryer. They found considerable of the cloth down at the north end, and also a portion near the center of dryer down, part of the cloth between still hanging on the racks. In the south half of dryer all the cloth still hung on the racks. The department pulled out the greater part of this cloth, which was down, when it was found that the cement coating had entirely peeled off from the burlap. Possibly twenty per cent of the cloth (that which had been located at the north end) was actually burned, and for a distance of perhaps twenty-five to thirty-five feet from north end cloth had been burned at the edges for a distance of perhaps one foot in. South of this point cloth was uninjured by fire, but was ruined by the heat in dryer, and by water, so that contents of dryer was a total loss.

A wooden roll, covered with card clothing, located on pipe rack at north end of dryer, roll being used in conveying the cloth, was badly damaged by fire, and the clothing burned off.

Building was heated by steam pipes at sides, and also at floor, all being

on iron, and those at floor directly under the festoons of cloth being on iron racks eight inches above floor, and with iron pipe guards situated thirteen inches above these steam pipes, the guards also being supported on iron and spaced about six inches apart. The object of these guards was to prevent a layer of cloth falling from the festoons above, and coming in contact with steam pipes. Live steam was used in pipes at a pressure of about seventy-five pounds at this point, and dryers were heated to a temperature of 135° to 145° F.

The origin of fire was unknown. There was a somewhat remote possibility that the oxidation of the linseed oil in cement on the cork carpet may not have been complete, or that some of the other constituents of the cement may have begun to combine under the influence of the heat of dryer, thus setting up spontaneous combustion, and producing fire. To offset this theory, however, it was said that such a condition always produced a penetrating odor and smoke long before fire actually burst forth, the composition smouldering and glowing at first. No such evidences were detected by watchman on night of fire. A more probable theory was that a festoon of cloth broke, and fell down in a heap on top of the guard pipes over steam pipes on floor. In this hot location gases were driven off from the coating of cloth, and may have become hot enough to take fire, being confined in the folds of the cloth. There was also a possibility that if such a festoon of cloth fell it might pile up high enough and lean over sufficiently to touch steam pipes at sides of dryer, which were not protected.

Considerable water ran out of ground floor of dryer into calendering room No. 26, adjoining on south, and damaged some machinery (calender, etc.), and also belting there.

This was probably one of the first fires occurring in linoleum or cork carpet dry rooms of reinforced concrete construction, and bears out the well defined theory that in the event of such fires the contents of such a dryer would be a total loss (assuming that only one dry room is involved).

The test of the construction of the building under such a fire showed up well, but it must be considered that the action of the automatic sprinklers exerted a powerful influence in preserving building and contents.

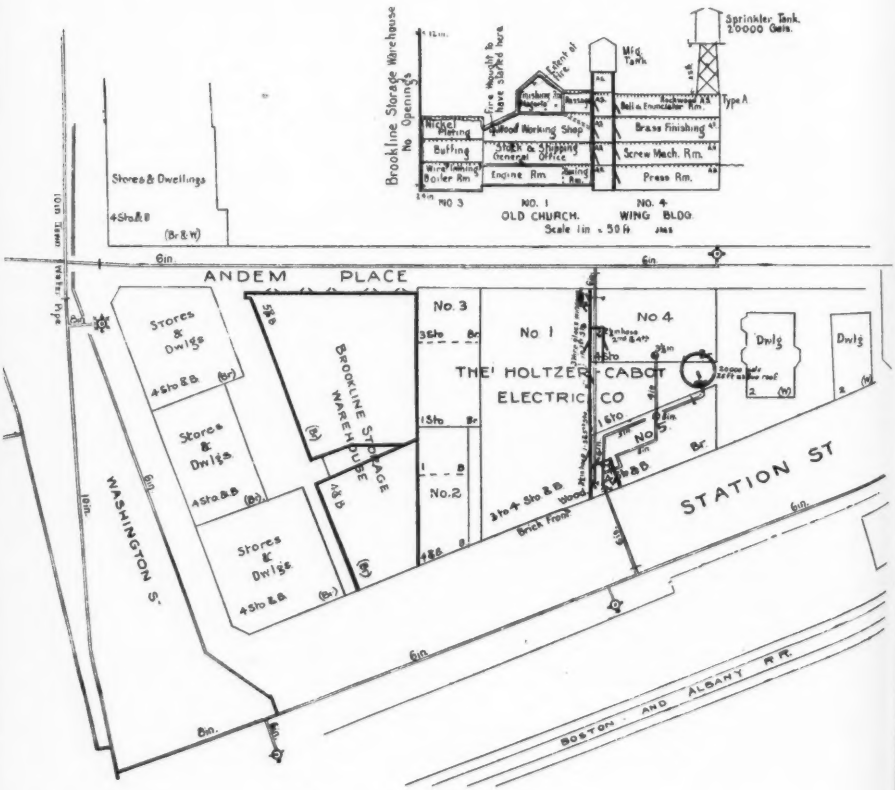
S-11668. Electrical Apparatus Factory. This plant consisted of two main sections; namely, a large unsprinklered section about 90 x 120 feet, largely frame construction, center part being an old church. Adjoining this and cut off by a good fire wall was a sprinklered section consisting of two wings, four stories high and a one-story section between them.

Fire wall was 20-inch first floor, 16-inch two floors above, and 12-inch at top floor. It was five feet parapetted at the ends, but in the central portion it dropped about six feet lower than the ends, as the sections adjoining were low. On the sprinklered side there was a one-story section and on the unsprinklered side the building was three stories with roof starting on third story level and running up to a peak some thirty feet from the fire wall. In the fire wall were several door openings, protected by fair 1¾-inch tin-covered fire doors equipped with automatic attachments and hung with

good, but not standard, hardware. On the second story, over the one-story section, there were some wire glass windows, but there was practically no fire at this particular point.

In the sprinklered section the stairs were in cut off towers with fire doors at each floor, and an elevator in the unsprinklered section connected with the sprinklered section on each floor, with a sprinkler head at the top.

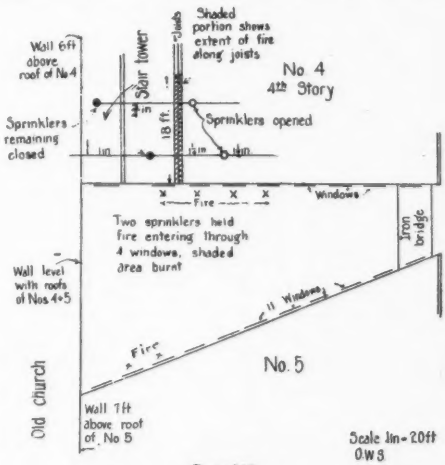
Fire is said to have been discovered by watchman at about 11.20 p. m. Alarm was also said to have come in from the old Ether tube American thermostat system, connected to fire department, about the same time. Fire probably started in woodworking department, third floor, old church building. The exact cause was not ascertained. When fire department arrived fire had gained considerable headway and second alarm was immediately sent in. The fire spread rapidly through the old rambling



S-11668.

construction, and it was soon seen that the section could not be saved. Efforts to prevent fire from spreading were successful, and neither the storage warehouse adjoining on the west nor the sprinklered section adjoining on the east were seriously damaged by fire. It was stated that about 17 or 18 hose stream were in use during the height of the fire. The fire was under control about 4 a. m., but the "all out" signal was not sounded until about 10 a. m. the next day.

The unsprinklered section was gutted, and while the two lower floors of the main section and the boiler house section were not completely burned out, the loss was nearly total. Fire damage in the sprinklered building was confined to a few windows on the top floor.



There was a heavy rain at the time of fire and practically no wind, with temperature about 45 degrees.

Fire doors, although not standard, stood the fire exceedingly well. Those in the main fire wall were considerably damaged on the two upper floors, although the tin covering is still in place and the core but little damaged. Fusible links melted and the doors apparently closed automatically unless they were closed when the fire started. The fire doors to the elevator tower, located in the unsprinklered section, were badly damaged on the upper floors. On the third floor the tinning was destroyed on the fire side and the top of the door had warped some two feet away from its support. However, it held sufficiently to prevent fire from getting into the elevator well to any extent.

Sprinkler system worked admirably and probably saved building from practically complete destruction. Primary supply was water works with a pressure of 95 pounds on the top line of sprinklers. Sprinkler heads opened in the following places: one head near fire door top floor, south section; one head near fire door, third floor, south section; two heads opened at top of stair tower, north section. Also one at top of elevator. Fourth floor, where four windows were burned out, one head opened.

Had the fire wall been full height for its entire length, there would have been much less damage in sprinklered section. As it was, the fire seemed to curl over this point and damaged six windows, tops of which were a few feet over top of fire wall. The sprinkler tank was located at

the east end of the building, spanning the two wings and about 50 feet from fire wall. The roof was entirely burned off and the side toward the fire badly scorched. Steel trestle which supported it was practically undamaged. After fire tank was found practically full, which showed that the street pressure was not lowered more than 28 pounds up to the time sprinkler system was shut off. This was done about 4 a. m.

This fire demonstrated the following facts:—

That in a condition where it is difficult and expensive to protect all of a plant, it is wise to protect even a part. (The owners considered the three following plans: reconstructing the church building; dividing the plant into three groups by five cut offs; installing fire protection in the wing building. The last plan was carried out.)

That an automatic sprinkler equipment is a valuable supplement to effective protection against exposure fire, even with a fairly good cut off wall.

S-11603. Clothing Manufacturing. This fire occurred in a small fire-resisting refuse vault in basement of main building. Walls and ceilings were of reinforced concrete. A small chute emptied into refuse vault and extended through all floors, with openings protected by fire doors. Fire entirely extinguished by one sprinkler. The sprinkler system was without alarm valve service, and the employees were not aware that there had been a fire until water was seen running out of vault.

The chief engineer was quickly notified, and he shut off valve which controlled all the sprinklers in main building. He opened a 2-inch drain which was the only drain available for all sprinklers in building. He also opened the one-half inch test pipes at top of risers to reduce the vacuum in the pipes while being drained. It required thirty-five to forty minutes to drain sufficient water from the system to reduce the water pressure so that the fused sprinkler could be replaced.

The water that was discharged from the sprinkler during the time the system was being drained, flowed over the basement floor and wet the bottom of about forty bales of cotton duck and a number of bales of felt lining. The water in basement was said to have been three inches deep in places. A large number of cases of finished stock were placed on skids by employees before the water reached them.

Had this fire occurred at night the water loss would undoubtedly have been much greater.

Showed the necessity of having self-draining floors and skidded stock.

H-6808. Garage. This was a one-story brick building having an open joist roof supported in part by wooden posts and in part by three structural iron columns. Fire was probably caused by back fire in carbureter of automobile on which the owner was working. Fire was fought and extinguished by fire department. A loss of about $100,000 resulted, about eighty per cent of which was due to loss of automobiles contained in garage.

This fire gives a most interesting demonstration of the effect of fire on iron columns. The first cut shows very clearly how two of the columns were buckled and twisted, and the portion of the roof supported by the three metal columns entirely collapsed. The second cut shows the stability of the timber posts under a severe test.

S-11608. Storehouse for Chemical Manufacturing Plant. The building in which fire occurred consisted of two sections, the east section being four stories high and the west section three stories high. There was a brick wall between these sections and standard fire doors were just being placed at the openings in this wall, but had not been put in position. There was an elevator, said to have been partly frame enclosed, at east end of four-story building, next to wall of the three-story building, and at the west end of the three-story building there was an open stairway. A new brick elevator shaft had been built at the south side of the three-story building, but fire doors here had not been put in place. Buildings were of joist construction, with single floors in part. Buildings also extended south with an ell, leaving an open courtyard about twenty feet wide. These buildings were not equipped with automatic sprinklers.

The east section was occupied for storage of acids in carboys first floor west end, and bottling ether (and also putting up in cans) first floor east end. The upper floors of both buildings were occupied for storage of ether in cans and bottles on shelves; also some collodion, sweet spirits of nitre, fusel oil, etc. On second floor at east end was a 600-pound cylinder of ether, and on this floor at west end was a 600-pound cylinder of collodion. Both of these went through the fire uninjured and without even bulging. There was also a large stock of bottles, mostly on third and fourth floors, in crates.

A couple of employees were pouring ether from a small cylinder into cans or other receptacles in first floor east building, and one man, about ten or fifteen feet distant, was soldering these cans with an electric iron, which appeared to have been laid on a plate or holder on the bench when not in use.

The two employees who were pouring ether got to scuffling, and one is said to have kicked the other, causing him to spill a quantity of ether on the table. The volatile liquid flowed along the table and struck the hot soldering iron. The vapor from ether became mixed with a proper proportion of air, and when the liquid reached the soldering iron a severe explosion occurred, which was followed by fire. The two hands who had been scuffling were badly burned, and the man with the soldering iron jumped out through a window into the street and escaped.

The fire which followed very soon attacked the ceiling of room, swept up the open stairway at west end, out through the open doorways into four-story building adjoining on west, and up the partly open elevator shaft there. Fire whistle at main plant of works across the street was blown and private fire brigade of factory turned out promptly and had on three streams in about as many minutes, followed by a fourth and fifth stream, using private hydrants. Hydrants were supplied by a 1,000-gallon pump, drafting from six-inch city main and from a 100,000-gallon reservoir. Reservoir suction was used almost entirely and six-inch filling pipe from six-inch city main into it was kept open. Reservoir was lowered about six inches. The 50,000-gallon gravity tank also supplied

hydrants, but was not drawn on. Engineer stated that 105 pounds pressure was held on pump.

City department reached factory shortly after the private brigade had their streams in use. The chief utilized the private hose streams, allowing the private brigade to man the hose and gave them directions as to location to work in, etc. It was said that the streams from city engines were not very effective above second floor, and the private streams were used from the roofs of south buildings in playing into fourth floor across the courtyard.

After a couple of hours of hard fighting, fire was well under control, being extinguished in about three hours. During the progress of the fire, there were muffled explosions from time to time, as a five-pound can of ether would blow up, or the top blow off of a five-pound bottle of ether. The vapor of ether was thick at times, being particularly heavy in basement of west building and the danger of serious explosion was imminent for a while. Fortunately the ventilation was good enough to carry off these fumes.

The first floor of east building, where fire originated, was badly burned out; the first floor of west building was somewhat burned at east end, but fortunately none of the carboys of acid here burst. Above the first floor, west building was more or less burned on each floor, especially at east end, where fire went up the elevator shaft and burned off a considerable portion of roof. Some fire went up the new brick elevator shaft at south side of east building, but very little fire got into buildings to south. Loss was rather heavy. The main sprinklered plant located across the street was uninjured.

It was unfortunate that owner had been unable to get the fire doors between buildings and at new elevator shaft in place, for in that case fire could probably have been held in the first floor in which it originated.

The prompt action of the private fire brigade prevented what would probably have been almost a total loss, for with the inflammable contents of buildings to feed on, fire would probably have been beyond control by the time city department could have arrived. It was commendable that the chief of the public fire department so well co-operated with the private brigade; and remarkable and very fortunate that no serious explosion occurred.

Fire showed the necessity of having floor openings properly cut off.

S-11680. Bleachery. This fire was due to an explosion in the gas pipe running from a gasolene gas generator to burners used at singeing machine.

This was a Springfield (Gilbert and Barker) equipment. The mixer and vaporizer were in a small frame house, thirty feet from mill, and the gasolene tank was underground close to this house. The air pump was located in the main building and the air pipe and gas pipe ran partly underground and partly overhead. Inside the building the gas pipe divided to feed four burners at singeing machine. There was a gauze flame arrestor in main gas pipe where it entered mill and about twenty feet from burners,

but no gauze at burners. It was thought that an explosion occurred in gas pipe between burners and flame arrestor and that the force of this explosion wrecked the flame arrestor, and allowed the flame to work back to the mixing chamber.

It is usual to install two sets of flame arrestors, one close to burners and one farther back in gas pipe. This was not done in this equipment. Since the fire additional flame arrestors have been installed and the equipment should now be standard.

Apparatus of this nature should be installed only by those perfectly familiar with such work, and great care should be taken to have all fire stops placed in the proper places and other details according to standards.

S-11532. Carriage Repository and Stable. This was a six-story brick building, of open joisted floors. Roof was supported by steel trusses. The top floor was divided into two sections by a wooden partition. One section was used for storage of shavings, hay and horse feed. The other section, where fire occurred, was used for storage of wagons, sleighs, wagon tops, auto bodies and odd storage.

Building was equipped with Manufacturers issue "C" sprinkler heads, on old schedule piping with side central risers. There were 265 heads on top floor. System was dry, controlled by a Wood dry valve. Supplies consisted of a gravity tank and a pump which drafted from a suction tank filled from city waterworks main.

First notification of fire was from ringing of sprinkler alarm in engine room at 7 p. m. No watchman employed. Alarm sent in from street box. Seat of fire was at a point farthest removed from main riser, and water pressure from tank was not sufficient to give equal distribution to all heads. Wagon bodies and tops obstructed sprinklers at seat of fire. There were 144 heads in section where fire occurred, all of which opened. Three heads in the other section also operated. The ceiling showed that the sprinklers spread an effective water curtain around fire and held it in check, but the tank was soon drained. The pump was then started. In the meantime the public fire department, after receiving a third alarm, responded with fifteen engines, from all of which streams were taken and poured into the building for nearly an hour before the chief entered to definitely determine size and location of fire. The private pump soon exhausted the suction tank, and the draught on the city mains was so heavy that the suction tank would not fill.

The fire damage was moderate, but the damage from water was very heavy throughout entire building, as firemen chopped numerous holes in all floors to allow the water to drain down. It was the general opinion that fire was being held by the sprinklers and that one hose or chemical stream properly used would have extinguished it.

Loss estimated at $20,000 to $30,000.

This fire shows the importance of having a primary supply of ample pressure; the necessity of having floors properly scuppered to handle water and save excessive water damage; and the need of having fire department officials familiar with the efficient work of automatic sprinklers.

S-11723. Department Store. This fire started in the fur storage room on seventh floor. This room was enclosed on two sides by a seven-eighths inch pine partition, lined inside with felt paper, and two sides were brick. The electric wiring in this room was in wood moulding fastened to a running board about seven feet from floor, and between the racks holding the furs. The fire was no doubt caused by the strands in the reinforced cord being broken and causing an arc, which set fire to the insulation. The loss was somewhat heavy to the furs and fur coats and considerable damage was done by water on the floors below, but very little damage was done to the building by fire. The automatic sprinklers had the fire practically extinguished when the fire department arrived. The local alarms and central station supervisory service in connection with sprinkler equipment operated very satisfactorily. The thermostats in this room in connection with the National Automatic Fire Alarm Service failed to operate. The reason for this failure was not stated. Loss $9,200.

H-6946. October 23, 1911. Tannery. Fire Discovered. Fire was discovered about 7 p. m. by a passerby, who immediately found the watchman in another part of the plant and notified him of the fire. The watchman then turned in the alarm by telephone, and central station responded, reaching the fire about five minutes later. The tannery was in plain sight of the East Ashland station, and the members of this Company discovered the fire and left before receiving the alarm. They arrived at the fire about fifteen minutes before central station. The watchman had left the building in which the fire was supposed to have originated a few minutes before the fire broke out.

Location of Fire. The fire was supposed to have originated in the tan wheel house and dry rooms. The origin was unknown, but it was supposed that a hot box on one of the fans was the cause.

Fire Fought. By two companies of the fire department, who were on the ground and had streams playing on the fire about 7.10 p. m. The chief, realizing the extent of the fire, communicated with the mayor, who called upon two outside departments. These departments reached the fire in about forty minutes.

There were eleven streams played on the fire. Eight of these streams were from double 2½-inch public hydrants. There were two 2½-inch streams from the company's pump and one 2-inch stream from private 2-inch single hydrant located near the boiler-house on 6-inch main.

All hose was in good condition, there being but one break, which was supposed to have been caused by the hose being run over by a vehicle. The pressure was estimated at from 60 to 65 pounds at central station until the fire had destroyed all of the property within its reach. The fire was never controlled, but continued to burn in spite of the eleven streams that were played upon it, and about 9.30 p. m. all of the buildings within its reach were destroyed.

Construction and Occupancy. The buildings were mostly of frame and iron-clad construction, with composition roofs, exceptions being the

four-story brick warehouse with approved composition roof, the engine and fan house and the oil house, both of which were of brick construction, covered with composition roofs. The occupancy of the buildings destroyed by the fire was as follows: finished leather warehouse, rolling department and leather storage, tan-wheel house and dry rooms, engine and dynamo rooms, oiling rooms, storage of supplies, storage of oils, yard building and liquor tanks.

Protection. There were numerous 2-inch standpipes throughout the plant, also water barrels and buckets and chemical extinguishers, but the fire, when discovered, had progressed to such an extent that this protection was rendered useless.

Remarks. The buildings destroyed were mostly of frame and iron-clad construction, and with the exception of the four-story brick leather warehouse, known as No. 1, all seemed doomed from the start. This building, however, could have been saved had the water pressure been sufficient to throw several streams upon its roof at the south end. This being the only building that could have been saved, the fighting forces should have been concentrated upon it, but this was not done. The opinion seemed to prevail that the structure was fireproof, and it was neglected until flying sparks and other burnable material carried by the wind and explosions to its roof burnt their way through, and soon the interior of the building was a mass of flames. The walls of this warehouse were intact when the surrounding frame area fell, and the standard fire-doors which protected the openings in the south wall successfully resisted the fire.

Total insurance involved $454,000. Nearly a total loss.

H-6516. June 26, 1911. Tobacco Warehouse. No. 1102 Broadway was a one-story frame, ordinary open joist constructed building with approved composition roof; two-inch floors; area, seventy by two hundred and eighteen feet. The front portion of this building was occupied as a loose leaf tobacco sales house, and the rear portion of building was occupied as a rehandling house. In the latter was used a steam ordering box, steam being generated by small upright boiler in small frame adjacent building. There had been no heat in building since winter.

There was a watchman employed at No. 1102 Broadway, but he was taken ill about 11 o'clock, and after locking up the premises went home without giving any notice to the owners.

No. 1136 Broadway was a one to two-story frame, open joist constructed building with metal roof and brick front; area, eighty-two by two hundred and sixty-six feet. Entire building was occupied for the storage of hogshead tobacco. There was no light or heat in this building, nor was there a watchman employed on the premises.

Neither of the above described risks had any private protection other than the watchman in No. 1102 Broadway, who had no clock. The public protection was good from three double-way hydrants on eight-inch water main and from five double-way hydrants on six-inch water main.

When fire was discovered by a railroad engineer about 11.35 p. m., it seemed to be in the southwest corner of building No. 1102 Broadway. There was a lamp in this part of the building, which was blown out by the watchman just before he went home. There had been no fire inside of the main building other than this lamp light. The boiler, which was in a small adjacent building, had been used in the afternoon before the fire. There were several rumors as to the origin of the fire. Some thought it was caused by the lamp, others from incendiarism.

Fire was fought by four companies of the city paid fire department, who were on the grounds and had streams playing on the fire by 11.50 p. m. No steamers were used, as pressure was sufficient. There were nine two and one-half inch streams played on the fire connected to double-way hydrants, two and one-half inch cotton jacket rubber-lined hose, varying in length from 150 feet to 500 feet. There was only one section of hose which burst and this was caused by a wall falling on it. This line of hose was attached to plug directly in front of No. 1136 Broadway. The fire was so intensely hot that it melted the Babbett metal in hydrant connection, putting it out of commission for the time being. The pressure was about ninety-three pounds from 11.40 p. m. until about 4 a. m., when the fire was under control, and it had then dropped to about sixty-five pounds.

The buildings were in exceptionally good repair and condition, and ordinarily one would not have supposed that one risk would have burned the other, as the buildings were 210 feet apart on the street line and 78 feet from corner in the rear of buildings. No. 1136 Broadway did not take fire until the departments were on the grounds and throwing streams on both buildings. The fire at No. 1102 Broadway was so hot and with the wind blowing from the southeast, that the firemen could not stand in the seventy-eight foot clear space at the rear end of the buildings. As the wind was blowing from the southeast, it carried the flame and heat directly toward No. 1136 and caught the southeast corner, and then seemed to go in a flash along the whole eastern side of the building. All the hogsheads in both houses were burned off the tobacco and also off the tobacco which was loaded in box cars on railroad switch running to building No. 1136. An engineer attempted to remove these box cars but was excited, and as soon as they had been coupled to his engine he threw the throttle wide open and his engine went forward with such force that it broke a coupling and only one car was removed without any damage. The other three were left standing on the switch and were burned.

The iron-clad hay warehouse and stable located at No. 1144 Broadway saved the entire block from burning. After it was seen that buildings No. 1102 and 1136 Broadway were sure to go, the chief directed six streams to be played on No. 1144. There was only one house damaged beyond No. 1144 and that was the brick, shingle roof dwelling located at No. 1148 Broadway. Several of the window casings were scorched and a hole burned in the roof.

Fire Causes.

The fires here given are selected to illustrate defects, either of construction or superintendence, in the classes of property indicated.

Common Causes.

H-6891. Electric Power Station. Thirty feet of iron breeching passed along rear wall within six inches of wooden window casings, venting to outside brick stack. Fireman said breeching always became "red hot" when plant was running under excess load. Several weeks previous window casings were set on fire, and this fire occurred at same place and from similar cause.

This shows the calloused attitude of many factory owners toward ordinary fire dangers.

H-6858. Cotton Warehouse. Fire caused by spark from switch engine.

This is a prolific cause of fire, and switch engines should be provided with spark arrestors.

S-11324. Woodworker, Class D. Overheated journal caused fire.

This is one of the commonest causes of fire in woodworkers, and journal bearings should receive most careful attention.

H-6947. Mercantile. Fire caused by rubbish in engine room basement.

H-6943. Metal Worker. Boy with candle set fire to barrel of paint.

H-6927. Foundry. Fire originated in waste can, due to spontaneous ignition of oily waste. Cover of can was open, so fire spread to a wooden post.

Standard waste cans only should be used.

H-6894. Shoe Shop. Sweepings and oily waste left in a wood rubbish box which someone had neglected to empty when factory closed down for the day. Loss $12.000.

Only standard refuse barrels should be used and these emptied frequently.

H-6893. Fire caused by carelessly igniting large pile of waste paper near heating furnace while this waste was being burned.

S-11696. Paper Box Factory. Friction of rope drive on box containing it. Box was charred throughout its length, and rope was destroyed.

Beltways and encasing around belt or rope transmission lines should be of ample size to prevent danger of contact.

S-11576. Canning and Bottling Works. Workmen cleaning machinery left oily waste in overalls. These were thrown in among empty tomato baskets and wooden boxes containing bottles.

Workmen's clothes should be properly cared for.

H-6821. Flats. Hot water pipes of heating plant became dry and the covering of pipes (supposed to have been asbestos) ignited.

This calls attention to the inflammable nature of some of the numerous brands of pipe-covering now in use. This is one of several fires which have been caused by combustible pipe-covering having the appearance of asbestos after it is in place, and which was accepted as such by the owners.

H-6343. Woodworker. Back fire from boiler. Fireman put some damp wood on the fire and then left boiler room. Gases formed, causing door of boiler to blow open, fire dropping on sawdust in front of boiler, which should have been cleaned up. Fire jumped through open window into wood refuse in open shed adjacent to boiler house wall and spread up wooden chute into mill. Wood chutes run from second to third floors of mill for purpose of conveying wood refuse to shed. This fire occurred April 3, 1911. Exactly similar fire occurred September 12, 1911, at same place.

S-11647. Crayon Factory. Believed to have been caused by dust collecting at bottom of brick fly wheel pit.

S-11621. Car Works. Workman built a fire in a metal pail to keep warm.

S-11618. Carriage Works. Spark from boiler alighted in dust on girder.

Boiler rooms, as well as rest of plant, should be kept clean and free from accumulation of dust.

S-11616. Bag Factory. Truck ran over match, which ignited burlap sacks.

This could not happen if safety matches were in general use.

H-6727. Woolen Mill. Night overseer shut down wheel and drove two wooden wedges under main rope drive drum to more quickly stop the drum on rope drive. These wedges became hot, setting fire to oil and ropes.

H-6714. Mercantile. Gas plate used for boiling water was located on a wooden bench with metal underneath, but no air space, and only six inches from frame partition.

S-11655. Knitting Mill. Spark from defective wire just above socket on drop cord set fire to the nap on goods in napping machine.

H-6833. Wood Preserving Plant. Boiler stack too close to roof woodwork.

H-6826. Candy Factory. Paper candy boxes piled on a deck to ceiling came in contact with electric wiring.

Stock should be kept two feet below ceiling.

H-6805. Stove Works. Employees hung their wet clothes over a coal stove in wash room. Properly arranged hooks were provided on walls, but men preferred to hang clothes as near stove as possible.

Steam pipes should be used in wash rooms and arranged so that material will not remain in contact with them.

H-6813. Planing Mill. Fire was caused by the overheating of one of the journal boxes to the shafting which is located in basement under the floor.

If shafting had been located on first floor instead of the basement it is probable that the fire would have been discovered in time to prevent the heavy loss which resulted.

H-6796. Mattress Factory. Fire caused by overheated bearings in feather storage room.

Frequent and careful inspection of shaft bearings should be made, particularly where, as in this case, they are liable to accumulate dust.

S-11589. Mattress Factory. Hot ashes placed on floor.

S-11584. Foundry. Spark from cupola lodged under eaves and set fire to roof.

Spark arrestors should be provided on cupola stacks.

S-11553. Cotton Mill. Match on floor was run over by truck.

S-11546. Paper Mill. Man stepped on match. This ignited fly and lint which men were sweeping down from timbers and hood over machines.

S-11547. Cotton Mill. Flying lint from carding machines caught fire from kerosene oil lamp.

S-11615. Water from leaking radiator ran down into cut-out box, causing short circuit.

Trivial defects may have far-reaching consequences, and should have immediate attention.

S-11603. Cereal Mill. Spontaneous combustion of oily waste in cornflake bin caused a loss of $6,000.

S-11610. Metal Worker. Overheated journal in jack-shafting up against floor joists set fire to oil-soaked sawdust and shavings thereon.

Great care should be used to keep bearings free from accumulation of dust and oil.

S-11669. Machine Shop. Overalls kept in paint room over night in wooden lockers. Fire broke out and was burning fiercely when discovered, probably due to spontaneous ignition in the wooden closets.

Metal lockers should be used for workmen's clothing.

S-11753. Woolen Mill. Economizer was cleaned by blowing steam through the tubes. This was blown into a small chimney, but some of the heated soot dropped on to dry shingles of the engine house.

Care should be used in the handling and disposal of such soot.

S-11592. Papeterie Factory. Fire was caused by spontaneous combustion of oily rags in metal can. Cover was left off and fire communicated to several wooden barrels nearby, which generated enough heat to open one sprinkler.

Keep refuse cans covered at all times.

Special Hazard Causes.

S-11719. Metal Worker. A vaporproof incandescent electric light, which was suspended over a crock filled with lacquer, in which an employee was dipping metal parts, dropped into the crock and set fire to the lacquer. The heat and water from the sprinklers caused the crock to break and the burning fluid ran over the cement floor.

S-11672. Metal Worker. Employees were oiling steel bars and rods in stock racks and had spread sawdust on cement floor to catch the surplus oil. Sparks from steam forge hammer, about fifteen feet away, ignited oily sawdust.

Great care should be taken where sawdust is used to absorb oil dripping.

S-11713. Furniture Factory. Fire occurred in a tin-lined vault for storage of paints, oils and inflammables. Spigot in barrel of mahogany stain leaked, and stain ran on floor and out of vault under door. Watchman discovered leak and set his lantern down to mop up the stain. Vapor ignited and set fire to the contents of vault.

Vaults for the storage of paints and inflammables should be constructed according to the specifications of this Association.

S-11693. Mercantile. Gas flame used to heat hat conformer stove was carelessly left burning, and in time the temperature became sufficiently high to ignite the wood boxing which partially enclosed the burner.

S-11608. Pharmaceutical Works. Spilled ether ran along a table and came in contact with hot electric soldering iron. An explosion occurred.

H-6715. Moving Picture Theatre. Machine was showing a picture and operating with power. Operator was rewinding a film on a bench across the room and had his back turned toward the machine. It is supposed that the film backed up into the light. He noticed a flash and turned to the machine just as the film exploded.

It was the general opinion that had the operator been turning the machine by hand he would have discovered the difficulty before a fire ensued.

H-6801. Moving Picture Theatre. Employee, finding it necessary to renew a burned out carbon, threw old piece of hot carbon on the floor, where it came in contact with reel of celluloid films.

Shows the thoughtless acts common to an irresponsible class of workers.

S-11600. Coffee and Spice Mill. Spark from coffee roaster was drawn into suction pipe from cooling drums.

S-11593. Wholesale Grocery. Sparks from hot coffee in cooling pans ignited accumulation of dust in metal exhaust pipe from cooling pans.

Employees had neglected to clean this pipe.

H-6854. Oil Boiling. Fire started in kettle in yard used for boiling tar. Kettle had been used for this purpose on day previous. A light tar distillate was also used in the kettle to thin the tar, and a portion of the mixed batch was left in the kettle over night. During the next day owner had instructed employees to start a fire in the furnace in order to melt the remaining batch of tar in the kettle. Fire was started and an explosion quickly followed, caused by the accumulation of gas in the kettle, which had been closed by a galvanized iron hood with a vent into the flue from the furnace portion of the kettle. Owing to the badly oil-soaked condition of the yard, the platform leading to the kettle and the premises in general, the fire spread rapidly and was extinguished with difficulty.

S-11727. Cotton Mill. Clean, white, spinning waste was being worked at the time of fire in a Kitson waste cleaner. Fire due apparently to foreign substance in stock.

All waste pickers, regardless of class of waste handled, which introduce into the room where located the hazard shown by this fire to be present, should be enclosed with a fire retardant partition.

Gasolene Fires.

H-6775. Cleaning Establishment. Clothing, which was being cleaned with gasolene, came in contact with hot flatiron.

H-6788. Church. Fire ignited in some manner by tinners who were working on roof at time, and were using a gasolene blow torch.

Blow pots or gasolene torches should not be used for burning paint off metal roofs.

H-6795. Garage. Gasolene and oil in canvas shield under machine ignited from spark from carburetor.

Never use combustible shield beneath a gasolene automobile.

H-6756. Automobile Factory. Overturning of gasolene torch set fire to oil and gasolene on floor.

S-11606. Lighted torch used to heat soldering iron ignited vapors from gasolene tank.

Points of Interest from Fire Reports.

These notes are intended to illustrate the efficiency or inefficiency of signaling, retardant or extinguishing agencies.

Alarm Service.

H-6878. Agricultural Implement Warehouse. Fire discovered by outsider, after it had made such a start that efforts to save property were of no avail.

An approved alarm service, either by watchman or automatic alarm, would undoubtedly have discovered fire in time to have prevented a total loss.

H-6726. Rolling Mill. Watchman asleep. Fire discovered by a farmer passing by.

Too little attention is frequently paid to the man in whose charge heavy values are entrusted for one half of the time.

H-6803. Foundry. When fire was discovered by watchman in another plant across street, practically one-half of the foundry was in flames.

In laying out watchman's routes thought should be given to avoid leaving portions of plant too long out of the range of observation.

H-6755. Stable. Office employee called fire department over telephone, but after several minutes wait, dispatched a boy to fire alarm box, fifty feet distant.

Private fire alarm boxes are always advisable.

S-11597. Shoe Shop. There was a Wall thermostat and a Walworth sprinkler directly over the fire. The sprinkler opened first, preventing the thermostat from fusing. An examination showed this to be a high test thermostat.

Care should be taken to see that high test thermostats are not used in needless locations.

S-11570. Rendering Works. Watchman discovered fire on regular rounds and was able to extinguish it with a couple of pails of water.

S-11631. Tenant Manufacturing. The alarm valve was an old lever check valve connected to central station. One head apparently operated at once, but alarm check was not sensitive enough to give the alarm. When another head operated the alarm was sent, and fire department responded. Fire was extinguished, but a needless water damage resulted.

Automatic Sprinklers.

S-11720. Metal Worker. Closely piled cases of finished stock prevented sprinklers from entirely extinguishing fire.

Care and thought given to the methods of storage would undoubtedly greatly reduce this ever-present hazard.

S-11631. Tenant Manufacturing. When fire department arrived fire was out, but they had difficulty in locating the sprinkler valve, as the stem of the valve extended down through two floors, with a wheel at the latter point, and considerable water damage resulted.

It is very important to have the valve scheme of a sprinkler system simple and in plain view. Also fire department heads should acquaint themselves with location of all sprinkler valves in their territory.

S-11671. Spinning Mill. There were fifty-seven heads opened in a room containing seventy-two, where a fire originated on a mule spinning frame. Pressure on sprinklers nine to ten pounds, but sprinklers said to have held fire well in check.

A greater pressure would undoubtedly have caused the fire to have been extinguished by the operation of fewer heads.

S-11568. Woodworker, Class B. Both water supplies were shut off at time of fire on account of repairs to circulating main supplying sprinklers and hydrants. Repairs had just been completed before fire was discovered, and the engineer opened city gate valve immediately after alarm of fire had been given. Twenty-two heads were opened in second kiln from south, where fire originated, eight heads in south kiln and four heads in adjoining kilns, through small openings in walls. Fire in first and third compartments was not discovered until two days after the fire, when repairs were undertaken, the sprinklers having completely extinguished the fire in these compartments without aid.

A good example of efficacy of sprinkler protection.

S-11576. Canning and Bottling Works. An outside storage platform alongside of plant, having a space of three to five feet underneath and an open joist roof overhead, was equipped with a dry system of automatic sprinklers, both under platform and under roof. A fire broke out at night among empty tomato baskets and wooden boxes and crates, but was quickly extinguished by the sprinklers. Would rapidly have assumed serious proportions had there been no automatic protection.

Shows the value of sprinklers in those portions often overlooked, such as shipping platforms, vestibules, etc.

S-11602 Mercantile. An automatic sprinkler at base of an outside brick rubbish chute, extending from roof to basement, promptly extinguished a fire which originated at bottom of shaft.

S-11665. Metal Worker. There was a hollow space in floor, formed by one-inch floor boards supported by two by fifteen inch joists, and a one-inch wooden ceiling underneath. There was an open space of several inches in floor under where fire occurred. Sprinklers were greatly handicapped in reaching fire.

Concealed spaces are always a handicap to effective sprinkler control.

Construction.

H-6715. Moving Picture Theatre. The efficiency of a good operating booth in case of fire was shown. Fire reached several rolls of films, but no damage was done outside of the booth. The projection openings were trapped with metal and held open with string. String burned and all the traps shut immediately. All woodwork in room was tin-clad.

S-11708. Warehouse. Fire occurred in second story of adjoining stable building, but entered second story of warehouse through an unprotected opening.

No openings on an exposed side of a building should be left unprotected.

S-11666. Power Building. Lighted cigar stub dropped on awning.

Wired glass windows kept blaze outside building.

S-11610. Metal Worker. Belt hole openings permitted fire to communicate to second floor, where sprinkler operated. The heated air found vent through these holes, so that the sprinklers on first floor did not operate.

Belt hole openings should be as few and as small as possible.

H-6822. Wood Worker. If engine room floor had been concrete, instead of wood, the loss would have been about $10,000 less.

H-6984. Restaurant. This was a brick building which was supposed to have been built in two fire sections. The brick division wall, however, extended only to the ceiling, and not through the roof. The fire, which occurred in section occupied as restaurant, burned through ceiling, and at once spread over entire buildings.

Fire division walls should be built in standard manner, with proper parapet through roof.

S-11745. Agricultural Machinery Works. Sparks from foundry processes lodged in workman's overalls just before placing them in a wooden coat closet.

This incipient fire again emphasizes the undesirability of wooden clothes closets indiscriminately located about a factory, and brings out the usual carelessness of workmen.

H-6893. Tenant Building. Building was divided into three divisions by cut-off walls. Two outside divisions occupied by a printery and inside division by a theatre. Dressing rooms in basement theatre section. Newspaper presses in basement at one side and editorial rooms in other side. Door opening in each division wall to allow passing from one section of newspaper occupancy to other section. Fire doors between press room and dressing rooms under theatre section did not close the upper part of door opening within a foot of the top, owing to steam pipes and ducts which passed through.

A fire occurred in press room half hour before a performance, but happened to be easily extinguished. If it had gained any headway it would have rapidly spread into theatre section.

S-11749. Cotton Mill. Waste houses should be of standard mill construction, and equipped with automatic sprinklers.

H-7032. Garage. Fire occurred in daytime, caused by lighting system.

Garage buildings should be constructed, where possible, with a maximum supply of daylight, so as to eliminate the continuous use of artificial illumination.

H-6820. Moving Picture Theatre. This fire resulted from the breaking of a film while passing through the machine. The focus was immediately cut off, but the broken end flapped over on the lantern box and took fire. As a considerable length of film had become loose before the machine was stopped, the burning film made quite a blaze, compelling the operator to leave the booth. The heat started the spare reel, enclosed in a metal case, to fume, causing considerable smoke, but the vent pipe carried the smoke to the outside. The accident happened while the exhibition was being held, and the audience, being small, left without any panic.

The fact that a standard booth for moving picture machine will tend to prevent a panic, in case of fire, was shown by this incident.

Exposure.

H-6771. Paper Mill Storehouse. Building was built of corrugated iron on skeleton joist frame, and was seriously exposed by a building in which there was located a wood-heated furnace containing tallow used for dipping lantern shells. Fire broke out here, and communicated to storehouse through light corrugated end.

Buildings should be protected by blank brick walls against a close or bad exposure.

Fire Department.

H-6866. Town had no fire department. About all that could be done was to try and save a little stock.

All towns should organize a fire department and have some apparatus for fighting fire.

Inside Protection.

S-11658. Mercantile. An employee, who discovered fire and sent in an alarm, used the hand hose attached to sprinkler system, and fire was practically extinguished before fire department arrived, and before any sprinklers had time to operate.

Hand hose, installed according to the sprinkler rules, are often very effective and prove the means of saving considerable water damage.

S-11428. Cordage Factory. Fire extinguished by use of hose from standpipe and three chemical extinguishers.

Standpipe protection is generally very effective.

S-11632. Department Store. On discovery of fire watchman immediately got a chemical extinguisher, and put out fire before sprinklers had time to operate.

S-11547. Cotton Mill. Fire extinguished by chemical extinguishers and several pails of water before sprinklers had a chance to operate.

H-6932. Foundry. Fire extinguished with practically no loss by employees with two and a half gallon chemical extinguisher.

H-6715. Moving Picture Theatre. Operator in machine booth tried to use two chemical extinguishers when fire occurred, but found them defective. He then used two water buckets and extinguished the fire.

H-6715. Moving Picture Theatre. Chemical extinguisher failure. Manager had recently equipped theatre with chemical extinguishers. He tried to charge them according to directions, but supposed that they were of the break bottle type and did not take the corks out of the acid bottle.

The covers of chemical extinguishers should be frequently removed and the apparatus examined by a competent person.

S-11570. Rendering Plant. A couple of pails of water were the means of saving considerable water damage from operation of sprinklers. These were promptly used by watchman upon the discovery of fire by him.

Fire pails and chemical extinguishers continually prove their usefulness, and they should always be installed in approved manner.

Management and Maintenance.

S-11586. Metal Worker. It was recommended that the piles of finished stock be arranged so that access could be gained easily to any particular spot. At time of fire stock was somewhat crowded, and this feature added both to the difficulty of locating fire and the amount of loss.

H-6887. Vinegar Factory. One stairway was trapped and the trap either had boxes stacked on it or it was caught in some way. This delayed the firemen and allowed fire above to gain considerable headway.

Patrol Service.

S-11592. Papeterie Factory. Water loss averted by efficient action of insurance patrol, who shut off water promptly.

Unusual Locations.

H-6822. Woodworker. Fire discovered at the extreme outside end of the sorting shed in sawdust made ground, which was less than five feet above water level and which generally holds a large amount of moisture.

Waterworks.

H-6806. Mercantile Building. Although the volunteer fire department responded promptly, they were seriously handicapped by lack of water and low pressure due to a neglected gate valve on pump suction at the waterworks pumping station. This gate valve was broken in an effort to open it to permit direct pumping pressure from a reservoir water supply. The only pressure available during the fire was that from a standpipe, which was very poor.

H-6851. The town had no system of fire protection, and as it was low tide in the bay it was difficult to procure water for fighting the flames, the only available supply being from wells.

Standard Rules and Requirements

PUBLISHED BY THE

National Board of Fire Underwriters

UPON RECOMMENDATION OF

THE NATIONAL FIRE PROTECTION ASSOCIATION

A copy of each revised edition of these pamphlets is mailed to members of the National Fire Protection Association on publication. Members desiring additional copies may obtain the same, without charge, by addressing the Secretary.

SUBJECTS.	Last edition.
Acetylene Gas Machines and Storage of Calcium Carbide	1910
Coal Gas Producers (pressure and suction systems)	1908
Electric Wiring and Apparatus (Nat'l Electrical Code)	1911
Electrical Fittings, List of Approved	October, 1911
Fire Departments, Private	1902
Fire Doors and Shutters	1908
Fire Extinguishers, Chemical (for other than fire department use)	1909
Fire Hose, for fire department use	1909
Fire Hose, for private department mill yard use	1909
Fire Hose, Unlined Linen, for use inside buildings	1909
Fire Pumps (steam)	1911
Fire Pumps (electric)	1904
Fire Pumps (centrifugal)	1911
Fire Pumps (rotary)	1911
Gas and Gasolene Engines	1910
Gasolene Vapor Gas Lighting Machines, Lamps and Systems	1910
Gasolene Vapor Stoves, for cooking and heating	1903
Grain Dryers	1901
Gravity Tanks	1910
Hose Couplings and Hydrant Fittings, for public fire service	1908
Hose Houses, for mill yards	1905
Incubators and Brooders	1908
Kerosene Oil Pressure Systems	1902
Lightning, Protection Against	1907
Municipal Fire Alarm Systems	1911
Nitro-Cellulose Films (storage and handling)	1910
Oil Storage (fuel), storage and use of fuel oil and construction and installation of oil burning equipment	1902
Oil Storage (inflammable), systems for storing 250 gallons or less of fluids which at ordinary temperatures give off inflammable vapors	1904
Oxy-Acetylene Heating and Welding Apparatus	1910
Railway Car Houses (storage and operating), Construction and Protection of	1907
Signaling Systems, used for the transmission of signals affecting the fire hazard	1911
Skylights	1906
Sprinkler Equipments automatic and open systems	1910
Steam Pump Governors and Auxiliary Pumps	1908
Uniform Requirements (standard mill construction, "inferior" construction, general hazards, oil rooms, general protection, stairway and elevator closures, watchmen, thermostats, etc.)	1911
Valves, Indicator Posts and Hydrants, for mill yard use	1910
Waste Cans, Ash Cans, Refuse Barrels, Fire Pails and Safety Cans for Benzine and Gasolene	1903
Wired Glass and Metal Window Frame Construction	1906
Underwriters' Laboratories, general information in reference to the nature of its work and the terms and conditions under which tests of fire appliances and materials are conducted	1911

NOTE: **Special lists** of Fire Appliances, Devices and Materials, and Gas, Oil and Chemical Appliances, examined and tested by Underwriters' Laboratories, Inc., under the above standards and deemed suitable for use, are mailed to members semi-annually in January and July.